MAY 11 1921

TELEPHONE ENGINEER

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The Automatic Reduces the Operating Costs to a Minimum

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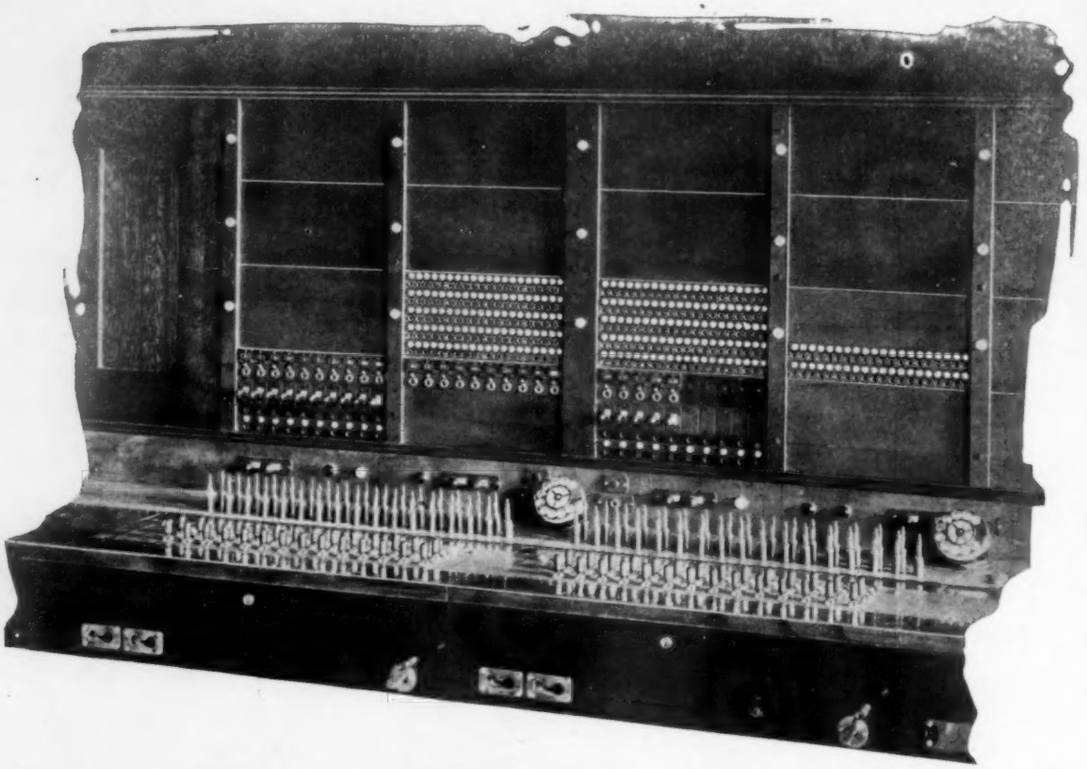

Common Battery and Magneto Service Combined

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The simple and rugged construction of parts used reduce maintenance to ZERO.

The cord circuits are positive in their action and require no extra supervision or care from the operators.

MONARCH SWITCHBOARDS are designed and built especially to fit the requirements of the exchange in which they are to operate and when you install a "MONARCH" you get the MOST switchboard service per dollar judged over years of service.

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A SYSTEM FOR EVERY SERVICE

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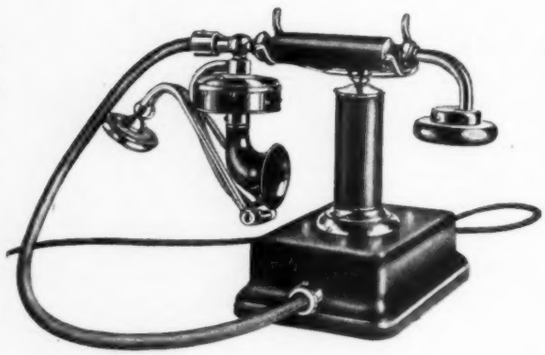
The Dynamic principle involved is the same as used in the now famous Magnavox loud speakers.

Write for Bulletin.



Magnavox Electro-Dynamic Telephones are used today on hundreds of ships and on U. S. Navy Destroyers.

Write for Bulletin.

THE TYPE D-2 IS A DESK TELEPHONE
PERFECT RECEPTION—PRICE $50—READY TO INSTALL

The Magnavox Co. Oakland, California

OPINIONS AND COMMENTS

MAKE IT STICK.

A recent telephone company advertisement carries a line of this tenor: "Salaries of telephone company employes, never up to the standard paid in other industries, cannot be reduced."

This is common sense and keen strategy, for the sentence appeared in an advertisement announcing an increase in rates.

It is common sense because it is because it is justice, and it expresses tangibly an appreciation of faithful and skilled devotion that puts itself above the contents of the pay envelope.

It is strategy for this is pay-reducing time in many industries. Thousands of readers of this advertisement will see in it a statement of corporation policy that they must believe will have a favorable bearing on their own income.

THE MIRACLE MEN.

Long into the hours of this night silent men will work that others may talk more, farther, cheaper.

One organization is credited with maintaining a staff of 2,800 engaged in telephone research work. There are scores of such staffs of lesser size incessantly busy.

Did you ever figure the pace these miracle men are setting for their brothers in the telephone business?

A few months out of touch and some startling telephone achievement is recorded. Another two or three months and this miracle is ancient history, so commonly employed that it seems it had existed forever.

Where is the telephone man who can stand still while the laboratory lads are plotting eternally to make his proud present-day plant a relic, almost overnight?

LAUGHING LABOR.

It is good to hear the comment of a visiting British industrial engineer who says: "If all industries so thoroughly met the problems of industrial fatigue as the American telephone industry does with its women employes, peace and prosperity would reign in business."

Facilities for promoting the comfort and emciency of operators represent one of a telephone company's best paying investments.

The merry phonograph, the tastefully arranged rest room, and the inviting lunch room, find their most advanced industrial use in the telephone business, and there's not an executive in the industry who doesn't recognize their value and encourage their extension.

Probably, we'll find in this one factor, a substantial reason why American telephone service is the quickest and most satisfactory in the world.

TELEPHONE ENGINEER

Vol. 24 CHICAGO May
No. 5 1921

443 S. Dearborn St.
Tel., Harrison 5962; Harrison 3049.

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W. H. Graffis.....Gen. Mgr.
Herbert Graffis.....Bus. Mgr.
H. B. McMeal.....Editor
Jos. M. Graffis.....Advertising Mgr.
E. Klappenbach.....Eastern Mgr.
56 W. 45th Street, New York
Tel. Vanderbilt 3695

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TELEPHONE ENGINEER is issued the 15th of each month. Copy can be accepted as late as the 10th of the month preceding date of publication. Where proof must be seen, allow ample time for transmission in the mails. Display Advertising—Rates on application. Classified Advertising—"Wants," "For Sales," etc.—$4 an inch, or 7 cents a word per insertion.

YANKEE WISDOM.

A bright ray in the telephone security market is reflected by the Manchester (N. H.) Mirror. Up in that section of the country they are real buyers. Perhaps you recall the illustration of 100 percent efficiency: a Hebrew buying from a Scotchman to sell to a Yankee at a profit. It therefore is significant to read, in these days of newspaper comments on telephone rate increases, the following words from the influential New Hampshire publication:

"American Telephone & Telegraph Co. and its predecessor, the American Bell Telephone Co., have paid dividends for the last 39 years at not less than 7½ percent, and for the last fourteen years at 8 percent. It recently has been increased to 9 percent.

"This is a remarkable record, made especially noteworthy by the fact that during this time there have been five distinct business depressions, some of them much more severe than the present one.

"Practically everyone in the United States who uses a telephone—and nearly everyone does—pays directly or indirectly into the treasury of the great American Telephone & Telephone Co. The company's policy of conservatism in its financial matters and strenuous efficiency in its service matters and the stable quality of the business—all render the stock's position seemingly a secure one, so far as earnings and income are concerned.

"Moreover, it is now selling for about $26 under the average for the past 20 years, and we do not believe that there is very much chance for ever again seeing it sell so low."

Let telephone security salesmen use publicity of this kind and market your offerings quicker.

How 5 Men Beat 9 Men's Work

This truck, carrying a collapsible Derrick designed in St. Louis, enables a five-man gang to do twenty-five percent more work than a nine-man gang working without it. "Dead men" and pikes are eliminated, as is also all danger to the workmen.

This is the "Morris Universal Hickey," so styled for want of a better name. It was designed by W. S. Morris, the Southwestern's superintendent of buildings and supplies at St. Louis, and has a four-way pull over pulleys.

Up she goes! A winch, operated by the truck engine, raises the pole until the butt is directly over the hole; then the pole is dropped into the hole.

The men merely steady the pole while the chauffeur lowers it into the hole. The "Morris hickey," which is fastened to the rear of the truck, enables a pull from any direction, and is specially useful in pulling underground cable. The collapsible forward leg of the derrick can be thrown over and rested on the ground behind the truck.

—Courtesy Southwestern Telephone News.

Miscellaneous Measurements

Methods and Means of Making Tests and Measurements of Continuity, Cord Circuit Operation, Cross Talk, Transmission, Talking and Ringing

By C. A. Wright

CONTINUITY tests are probably as much used as any other kind of test for showing whether or not there are faults in a telephone circuit and for locating these faults. The first test made on a line in trouble is generally a continuity test, and simple continuity tests are very useful in locating grounds, crosses and other kinds of trouble in central office equipment. Continuity tests, with other tests are essential as a final check on new or reconstructed equipment before it is cut into service.

The simplest equipment with which a continuity test can be made is a telephone receiver and dry battery. If a head receiver is used the hands of the tester are free to manipulate the test leads and to record results. Fig. 23 shows how this method of testing continuity may be used in identifying cable conductors in order that they may be properly connected to terminals of the distributing frames in central offices and in cable terminals on poles and in large buildings.

The testers must be careful not to be deceived by the charging current through the capacity between conductors which in long cables may be enough when the contact is first made to cause a loud click in the receiver. When the contact is broken and again made the click will be repeated if the current through the receiver is flowing directly through the conductor, but it will be greatly diminished or will disappear altogether if it is flowing through the capacity between conductors. The current through the capacity will not be noticeable in short cables.

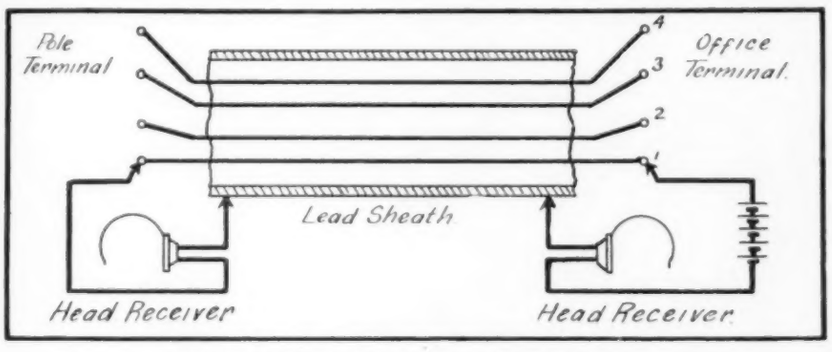

Fig. 23.—Method of Identifying Cable Conductors.

Continuity tests are frequently made by ringing a bell or operating a buzzer through the conductor under test, by means of a magneto generator. As the current in this case is alternating, care must be taken that unreliable results are not obtained because of the current through the capacity between conductors.

A convenient method of making a continuity test is by means of a telegraph sounder, or relay and sounder, and battery. The operation of the sounder when the testing circuit is connected to the circuit under test indicates that the latter circuit is continuous.

A wire chief's voltmeter affords a good method of testing for continuity, a steady voltmeter deflection indicating continuity. This method is frequently used by the operator or tester who makes routine tests on subscribers' lines, a steady deflection generally indicating that the subscriber has left the receiver off the hook. A discharge of proper magnitude from the condenser at the substation set as indicated by the momentary deflection or "kick" of the voltmeter pointer shows that the receiver is on the hook, and is an indication that the line is in good condition.

In many wire chief's desks, provision is made to shunt the voltmeter, converting it into a milliammeter. This instrument may also be used to test for continuity. Under some conditions it has the advantages that knowing the testing battery voltage, the resistance of the loop may be determined by a simple calculation. If I is the reading of the milliammeter in milliamperes and E the voltage of the testing battery in volts, the resistance of the circuit in ohms is

$$R = \frac{E \times 1000}{I}$$

It may be readily seen from the reading of the milliammeter when the plug of the testing circuit is plugged into a line jack how much current there is in the circuit to operate relays. Care should be taken when using the milliammeter that the testing current is not great enough to magnetize loading coils which may be in the circuit under test. When testing with a voltmeter, the instrument itself may be depended upon to limit the current. The wire chief's voltmeter is generally used to measure "foreign" voltage, which there may be on a telephone line. It may also be used to measure the voltage of the testing battery.

Tests made with circuits which duplicate operating conditions are found to be useful. The operation of cord circuits is checked by plugging into jacks, in the switchboard or in portable boxes, to which are connected circuits which by the operation of keys may be made to duplicate the various conditions on lines. The behavior of the cord relays will show whether or not they are in need of adjustment. A supervisory relay is frequently provided in a wire chief's testing cord circuit, the behavior of which will show whether the line conditions are such that the cord supervisory relays will operate properly. Duplicate circuits may be provided which will show whether or not there are conditions which will prevent the proper operation of coin collection and return circuits, line and cut-off relays and their associated circuits, and trip relays in ringing circuits of trunks. Circuits may also be arranged for testing interoffice and toll switching trunks, toll line circuits, and other circuits.

The most important element of telephone service is telephone transmission. In order to be sure that the subscriber receives what he pays for it is necessary to measure transmission. It is measured in terms of the length of No. 19 gauge cable over which may be obtained the transmission in question when

standard substation sets are used at the ends of the No. 19 gauge cable. The standard substation set ordinarily used in this country and abroad is the central energy substation set of the Western Electric Co. As it is not practicable to use No. 19 gauge cable in making transmission measurements, artificial cables are used. Each "mile" of artificial No. 19 gauge cable consists of four 22 ohm resistances and one .06 microfarad condenser, connected to form an H. In testing telephone transmission, it is necessary to find the number of miles of No. 19 gauge standard cable which in the standard circuit, will give the same transmission when talking over the standard circuit, as when talking over the circuit under test.

A standard of 20-mile transmission has been generally maintained for local service and 30-mile transmission for toll service. The limit of commercial transmission is about 35-mile transmission, although the voice may be audible over two or more times that length of No. 19 gauge cable. (For description of methods of measuring telephone transmission see article by author, Telephone Engineer, May, 1917).

After each telephone circuit is cut into service after construction, or repair a transmission test should be made to determine whether the transmission over the circuit is as good as the standard maintained for that kind of circuit. If not improvements must be made which will bring the transmission up to the standard.

Routine transmission measurements on telephone lines are made by some of the more progressive telephone companies. Such routine tests frequently indicate the existence of faults or of conditions conducive to faults which would not be indicated by other tests.

Fig. 24 shows the "standard" circuit and Fig. 25 shows the method of obtaining the transmission equivalent of three telephone lines between two offices. If the lines are looped in pairs and measured, and if the measurements obtained are $x + y = a$, $y + z = b$, and $z + x = c$,

$$x = \frac{a + c - b}{2}$$

$$y = \frac{a + b - c}{2}$$

$$z = \frac{b + c - a}{2}$$

It is possible for an expert tester to judge when the transmission over a circuit is 35-mile transmission. It is therefore possible to measure transmission by introducing sections of artificial cable into the circuit under test until the limit of commercial transmission has been reached. Then the transmission equivalent of the circuit is thirty-five miles minus the number of miles of standard circuit in the artificial cable.

Wire chief's testing cord circuits are frequently provided with an artificial line, by means of which the tester can judge whether or not the transmission of the line under test is satisfactory.

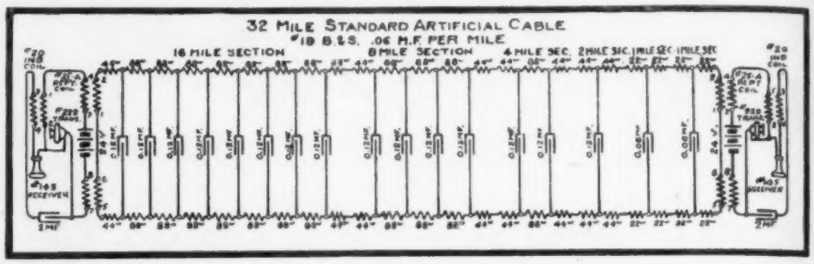

Fig. 24.—Thirty-two Mile Standard Artificial Cable.

Cross talk between telephone circuits may be caused by faulty design of apparatus or by the arrangement of any one grounded telephone line to the others in the same lead.

It is frequently desirable to measure cross talk. It is measured in billionths of the talking current in the disturbing circuit, which flows in the disturbed circuit, or "units of cross talk." A cross talk meter consists of a variable shunt which shunts the standard subset into which the tester is talking. The designations on the scale represent units of cross talk. The standard substation set which is used for talking and the receiver of the listening tester are switched back and forth between the circuits under test and the cross talk meter shunt, and the shunt adjusted until the received sounds are equal in each case. Then the scale on the meter indicates the units of cross talk between the two circuits. The cross talk meter is shown in Fig. 26.

There are many cases of inductive interference by which power transmission lines make telephone lines "noisy." Apparatus has been designed to measure the tendency of a given generator wave to cause interference.

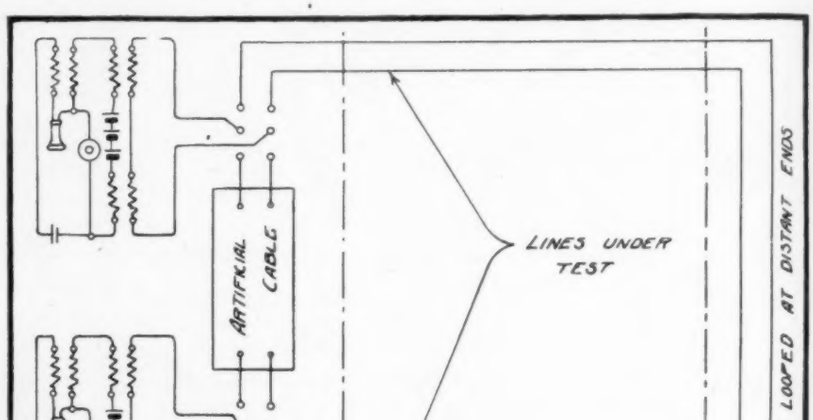

Fig. 25.—Method of Making Transmission Measurements.

It is the harmonics of the fundamental frequency of the voltage or current wave form which cause interference, rather than the fundamental wave itself. Most cases of inductive interference are electrostatic. That is, the interfering current flows from the power transmission line through the distributed capacity between the power line and the telephone line. The amount of this current is therefore proportional to the frequency of the harmonic of the voltage wave form which forces it through the circuit.

The amount of the interference varies with the frequency of the interfering current because the telephone receiver is affected more by currents of some frequencies than by those of others, even being resonant for certain frequencies, and because the ear is more sensitive to some frequencies than to others.

A network of condensers, impedance coils, and resistances has been designed through which will flow current for a given applied voltage which, for each harmonic will be proportional to the combination of the factors mentioned above. A meter connected to this network will read the sum of the effects of the various harmonics which there may be in any wave form. The network and meter may therefore be used to measure the tendency of a given voltage wave form to cause interference.

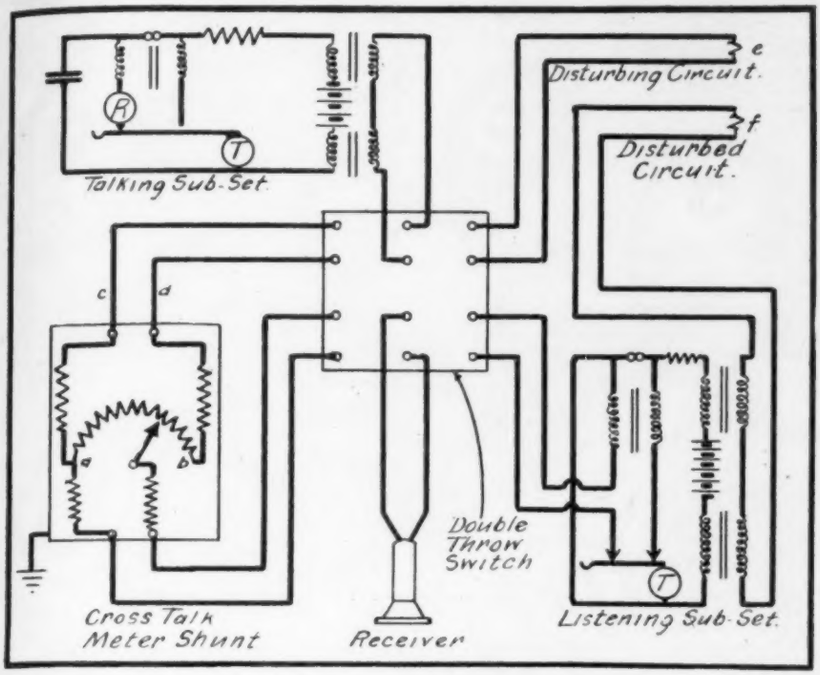

Fig. 26.—Method of Measuring Cross Talk.

Not only the tendency of a wave form to cause interference, but the degree of exposure of the telephone line to the power transmission line may be measured by means of a standard buzzer shunted by a variable resistance calibrated in "noise units." A noise unit is that amount of interfering noise which will decrease the intelligibility of conversation over a circuit to the same extent as the insertion of one-fortieth of a mile of standard cable in the standard circuit.

It is possible to analyze a wave form by means of an oscillograph or by means of a "harmonic wave analyzer." The latter instrument consists of an inductance in series with a variable calibrated capacity. A telephone receiver is shunted across the inductance. There are values of the capacity which will make the circuit resonant for the frequencies of the various harmonics. Any condition of resonance results in an abnormal flow of current through the circuit, and a "peak" of sound in the receiver, so that from the points on the capacity scale, the harmonics which are prominent in the wave may be found.

Fig. 27.—Wheatstone Bridge.

Test Sets, Test Desks, and Methods of Using Them.

The circuits for making resistance measurements, alternating current measurements, and the miscellaneous tests above described are assembled in various types of testing sets and test desks, according to the conditions under which the measurements are to be made.

Fig. 27 shows a small Wheatstone bridge in which provision is made for making Murray and Varley loop measurements. Fig. 28 shows a bridge which in addition provides a means of making bridge measurements of capacity. Fig. 29 is an insulation testing set. All of these test sets are portable and are well suited to use in small central offices, test stations, and in similar places. The testing cabinet shown in Fig. 30 contains a voltmeter and keys for making insulation and loop resistance measurements. It is frequently mounted at the side of the switchboard in small central offices.

A lineman's magneto test set is shown in Figure 31. It is provided with a transmitter, receiver, and magneto generator for making continuity, talking and ringing tests on telephone lines. It is conveniently portable and as indicated by its name is adapted to use by linemen who may be working on local battery lines. A lineman's central energy test set consists merely of a transmitter and receiver in series, with the necessary clips and cords for attaching the set to a line. With such a set a lineman may signal and talk to an operator or the wire chief in the central office.

An inductive fault finder is shown in Figure 32. Its use is described above.

The wire chief's desk generally used in large central energy telephone offices is provided with a high resistance voltmeter which may be shunted in order that it may be used as a low resistance voltmeter or as a milliammeter for measuring resistance such as the loop resistances of telephone lines. A relay and sounder circuit, an artificial line for measuring transmission, and as many as may be desirable of the circuits above mentioned which duplicate various office circuits are ordinarily provided. This apparatus may be connected to a testing circuit to which are connected several plug cord and key circuits. One of the latter may be plugged into a circuit to be tested so that it may be held until the testing circuit is free. Then the operation of the key associated with the plug and cord will connect them to the testing circuit. The conditions necessary for the measurements to be made are set up by the operation of various keys in the testing circuit.

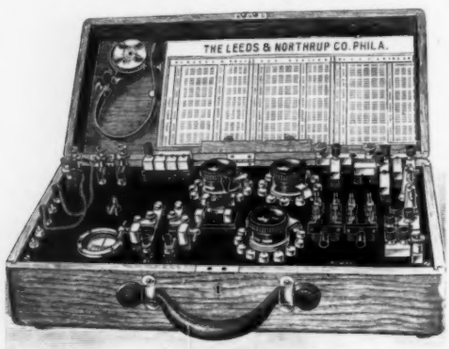

Fig. 28.—Wheatstone Bridge.

Frequently a voltmeter with a limited number of controlling keys and a cord and plug is provided at the "trouble" position in the operating room. If the routine tests on any line indicate that there are faults on that line a "plugging up" cord is connected to it. The other end of the plugging up cord terminates at the wire chief's desk, where a signal indicates to the wire chief that the circuit has been connected to a line to be tested. Trunks are provided at the wire chief's desk by which he may obtain connection with the switch board or main or intermediate distributing frames for communication or testing.

A frequent cause of "trouble" is the failure of subscribers to return receivers to switch hooks, so that the substation bells cannot be rung with low frequency ringing current. A "howler" delivers current of sufficiently high frequency that the tone from the receiver can be easily heard by the subscriber. A wire chief's desk is generally provided with a howler. As the tone is loud enough to be disagreeable or painful to the subscriber if he should happen to hold the receiver to his ear while the howler is connected to his line, great care is exercised in its use.

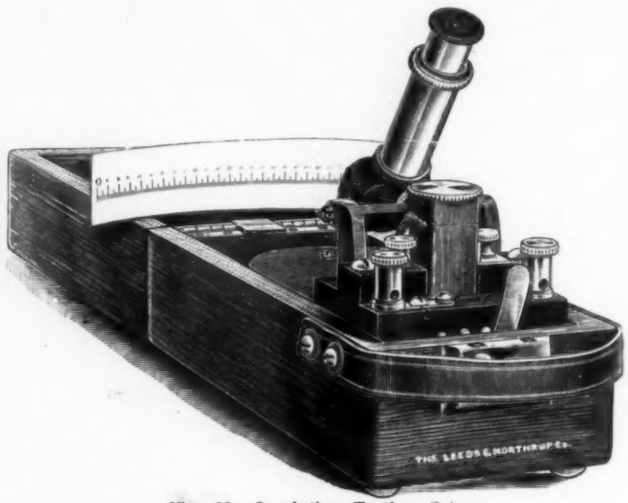

Fig. 29.—Insulation Testing Set.

A telephone set is nearly always provided for the tester, as the ability to listen and talk on the circuit under test is an advantage in analyzing the trouble, and locating it.

The arrangement of a test board for locating faults on toll lines is in general similar to the local wire chief's desk except that a Wheatstone Bridge arranged for making "open location" tests as well as resistance measurements is provided, and the artificial line and "duplication" test equipment is omitted. Figure 33 shows a large toll test board.

Recommended References on Maintenance and Testing.

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Fig. 30.—Small Testing Cabinet.

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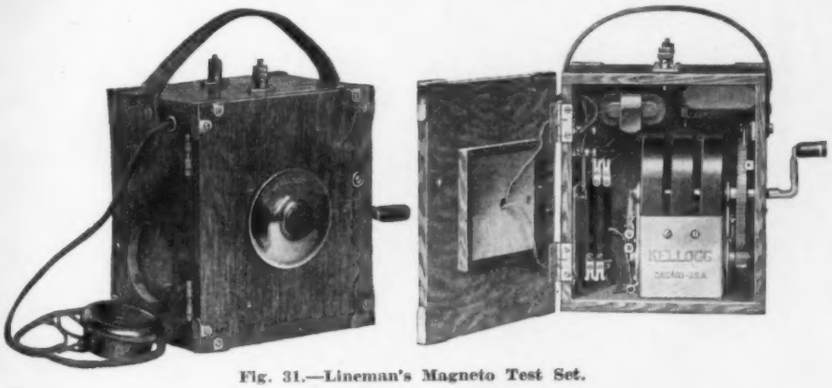

Fig. 31.—Lineman's Magneto Test Set.

References on Maintenance.

Fig. 32.—Inductive Fault Finder.

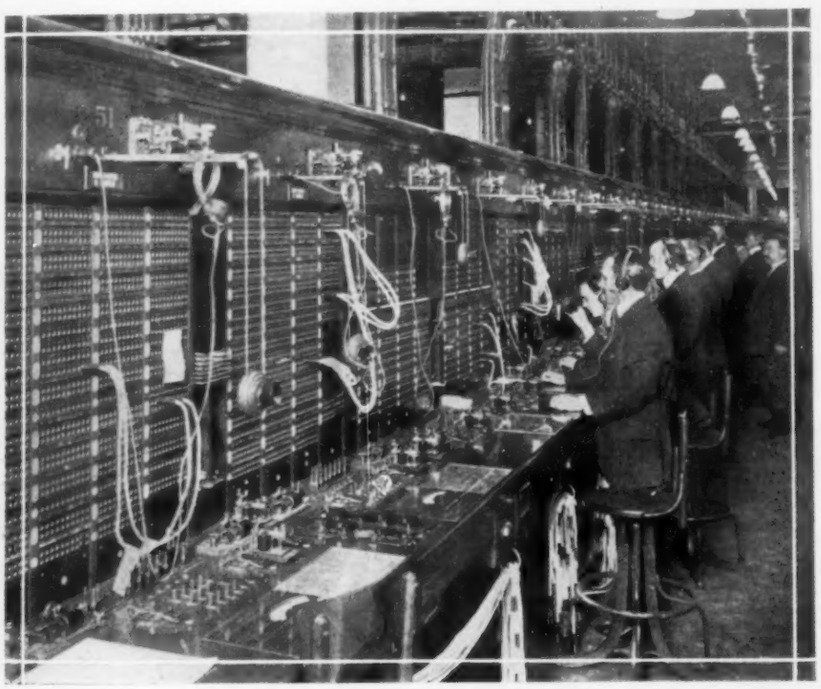

Fig. 33.—A Large Toll Test Board.

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Bank Advertises Telephones to Show Community Progress.

As an unfailing indication of civic enterprise the telephone is coming into its own. One of the latest significant evidences of this development appears in a Lincoln, Ill., newspaper. This journal comments on a bank advertisement which featured the local telephone company's work. Editorially, the publication says:

"The Edwardsville (Ill.) National Bank, of which Charles Boeschenstein is president, is carrying on a campaign heralding the progressiveness of the Madison County. In a recent advertisement headed 'The Voice of Progress,' it says:

"'More than 12,000 telephones and thousands of miles of wire in Madison county alone, give every town and village and more than a thousand farm homes immediate communication with all parts of the community and the outside world. A convenience at all times, the telephone is often a necessity. Without it the business world in its present complex development could not operate and many things which we look upon as indispensable could not be obtained.

"'Another fact is that of the revenue received for telephone service, one-half of every dollar is paid to employes for wages, and in this, too, the telephone contributes to the general welfare of the community.

"'This remarkable expansion of the telephone is another evidence of the growth and development of Madison county. It is an important factor in this bank's services to its customers.'"

Bank publicity and telephone company advertising are allied in their efforts for community progress. Much can be made of co-operative effort in the many opportunities that are offered frequently.

TEAM-WORK WITH BANK.

Employes' Savings Boosted and Company Is Advertised by Northwestern Plan.

Omaha, Neb.—Many Northwestern Bell Telephone Co. employes who gaze on a substantial bank balance in a few years will have Frank C. Builta, publicity manager of the company to thank for getting them started.

Like other financial institutions, the Corn Exchange National Bank of Omaha ran an advertisement comparing telephone service today with that furnished twenty years ago. Some very nice things were said about the value of telephone service and urging people to place their faith in the telephone company.

To the 1,400 Telephone People in Omaha
The co-operation of your company makes it easier to save now than ever before.
Have you opened your savings account?
One Dollar will start an account in our Savings Department.
Our officers will be pleased to have you consult them in regard to your banking needs and will assist you in arranging to save.
By availing yourself of the experience, the facilities and the helpful service of this bank you can make the best use of the opportunity your company has offered you.
United States National Bank
N. W. Corner 16th and Farnam Streets.
The Bank of PERSONAL Attention
Telephone Service
BACK in 1900 Omaha boasted of having a great telephone service. There were then 3,344 phones in use. They were the old "on-the-wall" kind. We rang a bell to get Central—connections were bad—it was hard to hear. Then came the desk phones—these were a very great improvement over the old style phones, and during their period of service their popularity has so increased the demands on the Telephone Company that today Omaha has 54,172 phones in use.
The New Automatic System is now about ready. It, too, will prove of still greater value. Omaha is a fast growing city—and to keep pace with a telephone service that is INVINCIBLE is no light task. But Omaha may have no fear, for nowhere will you find a more progressive, more determined body of men working to satisfy your wishes.
The Corn Exchange National Bank is proud of the telephone company's service record. It is an asset for a greater Omaha. And having in mind the facts that your success, and ours depends upon a still Greater Omaha, we ask that you place your funds in the Nebraska Telephone Company as one of its assets, and keep on boosting for a Greater Omaha, your home town.
CORN EXCHANGE NATIONAL BANK
The Bank With an INTEREST in YOU
1503 Farnam Street
To Omaha's Telephone People
How much do you have, and where do you keep it?
Are your Savings serving something for you?
Are you one of the people in Omaha who has been working for several years, but has nothing to show for it, or are you Saving for Future Needs?
Get the Saving Habit
There is much satisfaction and a feeling of independence in knowing that you are Saving something, no matter how small the amount may be.
And the Northwestern Bell Telephone Company—your Company—has generously offered to assist you.
All you have to do is open an account. One dollar will do it.
Avail yourself of the experience, the facilities and the helpful service of the Savings Department of this bank.
United States National Bank
N. W. Corner 16th and Farnam Streets
The Bank of PERSONAL Attention
Stenographer
Clerk
Operator
Lineman
Lineman
Telephone Employes—Are You Saving?
Your great organization—the Northwestern Bell Telephone Company—has established a savings plan to help you to safeguard your future.
Embrace this opportunity at once—today.
You cannot afford to be without a savings account.
The United States National Bank stands ready to provide efficient banking facilities for your savings.
One dollar opens an account.
Safety, security and personal attention is provided at this bank.
United States National Bank
N. W. Corner 16th and Farnam Streets
The Bank of PERSONAL Attention

Proofs of These Ads Supplied Good Examples.

Shortly afterward announcement was made of the plan of the Northwestern company to assist employes to save. This plan provides for the employes having savings accounts or thos employes who might open new ones to issue orders to the company to deduct from their regular pay a certain amount periodically to be sent direct by the company to any bank which the employes might designate. The plan further provides that the control of the bank account will at all times be in the hands of the employe.

One of the first banks to take advantage of the announcement of this plan to advertise to telephone people was the United States National Bank of Omaha, Neb. This bank ran several newspaper advertisements encouraging telephone employes to open accounts in their savings department.

With the thought that other banks might desire to run similar advertisements if they had copy to follow Builta's department had proofs printed of the Corn Exchange National Bank and United States National Bank advertisements. The proofs of these bank ads were distributed to Northwestern local managers throughout the territory, and they showed them to the banks in their towns.

Several other banks have already taken up this advertising plan.

SPENDING MONEY.

Telephone Companies All Over U. S. Push Ahead With Big Construction Programs.

Favorable prices and quick deliveries now available have launched a considerable volume of telephone construction work, despite the general industrial letdown. A casual survey of the industry shows the following territories are to see action on construction plans:

Illinois Bell Telephone Co. expects to spend approximately twelve million dollars in the state of Illinois alone during the coming twelve months.

Twenty thousand dollars is to be spent on the Chattanooga, Tenn., exchange of the Cumberland Telephone & Telegraph Co.

Yakima, Wash., is to get added equipment as part of the Pacific Telephone & Telegraph Co. building program. During the past 18 months more than $120,000 has been spent on the Pacific's Yakima district in getting the expansion campaign under full sway.

Southern Bell is spending $20,000 in Gadsen, Ala., thus making good its promise laid down when it asked the Alabama Public Service Commission for increased rates.

Fairmont, W. Va., is the center of long distance construction work being done to relieve the over-crowded condition of Pittsburgh-Fairmont lines. Advantage is being taken of the general slump in business to build for the inevitable rush.

At Paris, Texas, the Southwestern Telephone Co. is spending $40,000, bringing the system up to concert pitch.

According to Fred Davies, assistant superintendent, the Interstate Utilities Telephone System will spend $85,000 for additions and improvements on the company's Eastern Washington and Northern Idaho property.

Advice from Tampa, Fla., is to the effect that the Peninsular Telephone Co. will spend a $250,000 fund under supervision of its board of directors. Acquisition of the Highland Telephone Co. will account for part of the expenditures.

Edward M. Taylor, Lynchburg manager of the Chesapeake & Potomac Telephone Co., says $40,000 is being spent on the Lynchburg cable construction program. Other expenditures for service expansion are scheduled for the near future.

Brevard (N. C.) Plant Changes Owners. Busy Constructing.

Brevard, N. C.—Citizens Telephone Co. took charge of the Brevard Telephone Co., April 1. Construction work is being vigorously pushed by the new owners.

Record Crowd Really Hears

125,000 Hear Every Syllable of President Harding's Inaugural Address—Loud Speaking Phone Passes Test of Severest Kind Without a Flaw

J. P. Malloy "Tuning-Up" at the Final High-Power Amplifiers. Three Tons of Equipment Was Located Under the Steps of the Capitol. Men Stood Ready to Switch in the Duplicate Equipment in Case of Emergency, but Everything Went Along Without a Hitch.

—Photograph by Harris and Ewing.

President Harding's acquaintance with the telephone industry has been no inconsiderable factor in his success in public life. Particularly during his campaign for the presidency did the telephone play a part of ever increasing importance and achievement. Starting with the nomination at Chicago, figuring prominently during the campaign and working up to a historic climax at the inauguration, the loud speaking telephone can claim to have aided Harding in a most decided manner.

Years of patient and costly research preceded the installation of the Bell loud speaker at Washington, which enabled the President's inaugural address to be heard with amazing clarity by 125,000 people—the largest crowd that ever assembled to hear one man's voice.

Makes Telephone History.

In telephone history March 4, 1921, will go along with January 25, 1915, the date of the opening of the transcontinental line, according to Bell forecasters. It probably marks the date of a revival of the fine art of political spellbinding also, for now political speakers, knowing they will be heard, may say something. In their training they may even follow the example of the ancient orator who perfected his enunciation by practicing with a mouth filled with pebbles.

Details of the notable event are given by the Chesapeake and Potomac Telephone Company's excellent publication in the following paragraphs:

"There is magic in the human voice. Such magic that when telephone men told the world that everyone who could crowd upon the vast open spaces before the Capitol building could actually hear Warren Gamaliel Harding take oath as twenty-ninth president and deliver the address which was waited for by every government on the globe, the interest of the world lay first in the hearing of the speech and next in analyzing its import.

They Came to Hear.

The promise that everyone could hear was not an empty one. The crowd which began to appear on Capitol Hill in driblets at 8 o'clock on the morning of March 4 grew to a size that no man could measure or count. It stretched right and left beyond the long porticos of House and Senate, and out in front of the imposing center, across the lawn to the steps of the Congressional Library—so far in fact that the powerful lenses of the largest cameras could not see the outer edges—and yet in all that crowd everyone heard the inaugural address, 'clearly, distinctly and pleasantly,' to quote the prediction of Secretary Warren E. Martin of the Joint Congressional Inaugural Committee. Mr. Martin and Andrew W. Mellon, new Secretary of the Treasury, who were present at a preliminary demonstration of the Bell loud speaker, were amazed at its power. They heard the words, and what is more they heard those shades of tone and inflections of voice which modify the strict meaning of the printed word, and without which a speech is but a wooden recitation rather than the message of a living man.

Never before March 4, 1921, have so many people heard a speech—and in hearing the inaugural address of Warren Gamaliel Harding they felt it as well. No man, from the fabled orators of the Greeks down to the great speakers of our own day, has talked to so many people who heard and understood. It marks a new day in the psychology of the spoken word, and an opening of a new lane of possibilities.

It represents the supreme achievement in voice dissemination, say the Bell men.

Remarkable to those who heard the voice of the President carried over that multitude was the fact that they saw no machinery and no equipment. All they saw was the inaugural stand built midway of the main steps of the Capitol itself. Its principal characteristics were four Corinthian columns. Supported by the columns was a roof of classic architecture; a cornice and above that a railing of careful and proper design.

It was within the roof the great horns lay. Invisible, they formed a most important part of the loud speaking equipment of the Bell loud speaker. Beneath the stand and under the steps of the portico, was the complicated machinery to be used in amplifying the President's voice.

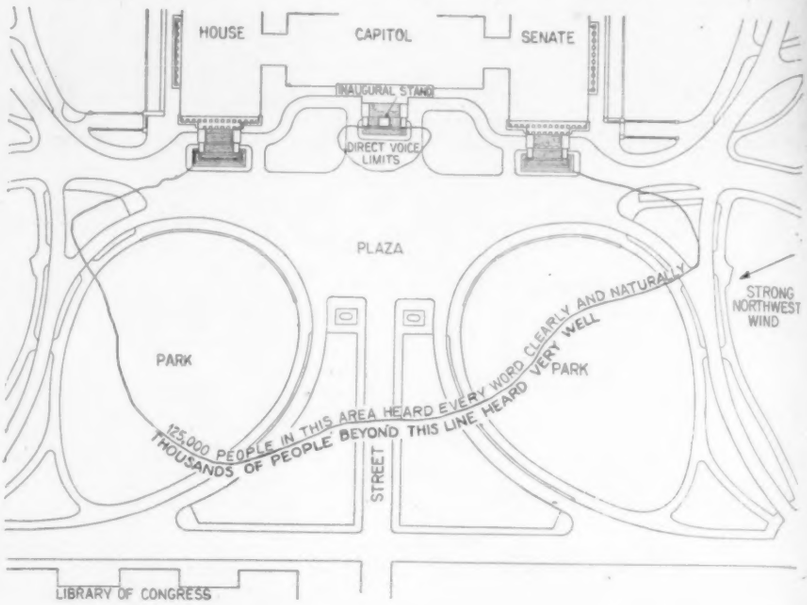
Back to Earlier Days.

Every inauguration day in Washington has had a character of its own. There have been simple inaugurations, and there have been inaugurations of the most complex character, marked by spectacle and pomp; but not since the very earliest days have people gone to the inauguration merely to hear the keynote of the goverment for the four years to follow.

The Harding inauguration was marked by the fact that the sole feature was the inaugural address, which was heard by everyone who went to hear it. No matter where they stood they heard. In the space in front of the Capitol it is possible to crowd five hundred thousand people. It is probable that five hundred thousand people were not there—but had there been that many they would have heard the speech, and the oath preceding the speech. But it is entirely probable that two hundred and fifty thousand people heard; and one of the odds and ends of gossip picked up that afternoon was that employes of the Congressional Library, seated in the golden cupola of the building twelve hundred feet away from the inaugural stand, heard the speech.

Without the Bell loud speaker it is certain that the inaugural ceremonies, to the great public, would have been unsatisfactory. They would have been as simple as the ceremonies of March 4, 1801, when Thomas Jefferson, accompanied by several fellow boarders from a New Jersey avenue boarding house, walked over to the unfinished capitol and took the oath and delivered his address in what was then the Senate chamber. Or perhaps without the Bell loud speaker the simple Harding ceremonies would have reminded historians of the first inaugural address delivered from the steps from which President Harding spoke—that of "Old Hickory," President Andrew Jackson, who walked to the capitol from somewhere up-town, surrounded not by the militia, but by delighted friends. They watched him deliver his speech, and he watched the crowd, through two sets of eye-glasses. But only a few heard it; and in their desire to hear they later stormed the White House and were in a fair way to demolishing the famous East Room.

Probably there was never a crowd like that which heard President Harding's inaugural address. It was good-natured, partly because it knew it would



Map Showing the Capitol, the Plaza and the Grounds Beyond. Note the Difference in Area Between the Space Enclosed by the Line Indicating the Limits of the Unaided Human Voice and the Space Enclosed by the Irregular Line Showing Where 125,000 Stood.

be able to hear without jostling to the front. There was none of the crowding cruelty which maims and sometimes kills the woman or child who is caught in the press of an unthinking crowd. The newspapers of Washington had told their readers that the voice would be distributed all over the plaza and the park, and naturally there was no great rivalry for front positions. The only seats on the whole capitol grounds are a row of stone benches several hundred feet from the inaugural stand. The earlier arrivals, instead of pre-empting front-line positions, took those stone seats and heard perfectly.

A Voice From the Air.

As the crowd waited they became aware of a voice speaking. It might have come from the cloudless sky, for all the waiting thousands knew—but actually it was the voice of a Bell engineer, W. D. Pomeroy, trying out the Bell loud speaker. This is what he said:

"I am speaking over the Public Address Telephone System installed by the Engineers of the Bell System.

'The systems consists essentially of three parts; a special transmitter, located directly in front of me; a series of vacuum tube amplifiers, located in a control room, and through which the minute electrical current from the transmitter is amplified, and loud-speaking telephone receivers attached to large wooden horns located in the superstructure of this stand.'

The President Enters.

Suddenly there came a ripple of applause from the capitol doorway. It spread through the stand and the thousands of people. Warren G. Harding was descending the steps. The band played and as he came to the rail a great cheer arose, and he smilingly bowed his acknowledgement. Below stairs all was in readiness; the Bell loud speaker was cut into service. Chief Justice White, in his deep voice, uttered the first words of the oath. His voice came from the horns with great clearness and carried over the crowd. The effect was impressive. The thousands stood at attention and the silence was profound.

Slowly, and with dignity, but with great clearness, his left hand on an open Bible and his right hand raised, President Harding repeated the oath, phrase by phrase, after the Chief Justice.

"With Great Clearness."

His voice came from the horns with great clearness and carried over the great crowd. The effect was inspiring. The thousands stood at attention and the silence was profound. Not a sound sought to compete with the voice from the platform, save only the rustling of

—Harris and Ewing.

A. T. and T., C. and P. and W. E. Miracle Men, Responsible for the Inaugural's Loud-Speaking Success: Top—F. J. Ward, Earl Godwin, J. F. Slaven, J. G. Truesdale, R. H. Ross. Middle Row—E. Graeves, C. J. Owen, J. Sehfuss, J. P. Maloy, E. R. Albrecht, J. B. Sweeney, H. L. Barkley, F. W. McKowan, F. A. Hubbard, C. L. Garrett, J. B. Riley. Bottom Row—D. S. Blattner, W. D. Pomeroy, H. S. Hamilton, J. M. Leonard, G. L. Weller, G. K. Thompson, H. A. Frederick, H. F. Elsasser, J. F. Steel.

the garlands draped about the ballustrade.

The President began the reading of his address and immediately it was apparent that he was being heard everywhere. In other years those fortunate enough to get within a hundred feet of the inaugural stand could hear the speaker; others merely saw him. But this time every one heard and understood.

Applause from the crowd did not interfere with the delivery of the address. So clear was the voice that carried out over the crowd it overcame other sounds. Indeed, the applause on the outskirts was probably not heard by the President, so great was the distance.

Reproduction Perfect.

The reproduction of President Harding's voice by the Bell loud speaker was so perfect that those in the first rows could not tell where the natural voice left off and where the amplified voice began. If one could have walked away in a straight line from the platform he could have detected no change in tone and but small variation in the volume. In the distance the sound was as clear as in the first row. It was a perfect demonstration of the new art of voice amplification.

There is no doubt the Bell loud speaker was a marked success at the inauguration. All Washington that night talked of the wonderful clarity with which the President could be heard.

When President Harding had departed, the doors of the control room were opened and people were permitted to pass through to view the intricate equipment used to carry the President's voice. Ushers from the commercial office of the Cheasapeake and Potomac Telephone Company were present and explanatory signs were placed on the various pieces of apparatus. Hundreds of people entered and viewed with great interest this electrical development that bids fair to have a far-reaching effect on the lives of the American people—a development destined to have a part in the spread of truth and righteousness. It marks the renaissance of American oratory.

The plant consisted of a system of motors, generators, wires, transmitters, amplifiers and other electrical equipment weighing several tons and filling three rooms. And it was most delicate machinery, requiring the utmost care in its operation. A drop of water or a piece of metal the size of the head of a pin would have put the whole plant out of business.

None of this apparatus or machinery was in evidence. The speaker himself saw nothing of it except the small transmitter boxes that stood just in front of his desk. Even these could not be seen by the audience.

These were remarkably delicate and sensitive transmitters, but adjusted to an infinite degree, carefully shielded with copper, which, grounded, carried off any tiny current that might interfere, and these ultra-sensitive transmitters caught every variation of the voice with fidelity.

How It Was Done.

The transmitters picked up a minute part of the energy created by the President's voice. This was carried by wires from the transmitters to the intricate apparatus in the control room and stepped up through successive stages of amplification. In each stage the energy was led into a vacuum tube amplifier. The tones which left the horns followed the tones of Mr. Harding's voice with exact fidelity, but with a force of a million voices.

Provisions were made for the possible breaking down of the apparatus. Every piece of equipment was in duplicate—two of everything but the group of horns. Throughout the address men stood at the apparatus, their hands on the switches, ready to throw the current into the emergency equipment if necessary. But the need did not arise.

The transmitters were set in the railing of the speaker's stand. A transmitter together with the amplifying tubes and certain other portions of the apparatus, will have a place in the A. T. and T. Museum, to be shown future generations as the equipment that carried the inaugural address of President Warren G. Harding.

Much testing of the equipment was necessary, and this phase of the job was done in the days and nights immediately preceding the inauguration.

Each horn was a separate problem; each horn had to be adjusted according to the space in front of it, the distance the sound would have to travel, so that the voice coming out of the several horns, would be uniform. Men were stationed on the plaza, at different points, to catch these sounds and check them up with the men in the control room by means of telephone circuits. This work required the utmost co-operation and co-ordination.

No Limit to Audience.

Had the inauguration taken place in an open space, without any building for a background, the voice would have traveled in all directions, instead of fan-wise. The people behind the speaker could hear just as well as those in front. Under such conditions one man could talk to a million people at the same time.

Making the tests were not without humorous features. The inaugural

stand was not far from the Supreme Court chamber, where the members of the nation's highest law tribunal were listening one day to an important decision. Suddenly there was a blare of a dozen bands, playing a popular tune, seemingly in the courtroom. The telephone engineers were demonstrating the reproduction of music. The sounds carried into the court room, interrupting the Chief Justice reading the decision. Apparently he enjoyed the concert, for he stopped his reading, put down his papers and listened until the selection was finished.

Those Who Did It.

The offer of the use of the apparatus at the inauguration—the gift of the Bell System to the people of America—was made to the inaugural committee of Congress by A. E. Berry, president of the Chesapeake and Potomac Telephone Co., and the general arrangements for the demonstration were looked after by Mr. Berry, assisted by Earl Godwin and John F. Slaven, executive assistants, and other C. and P. officials.

Preparations for the demonstration were begun three weeks before the inauguration and were carried out by the Long Lines department of the American Telephone and Telegraph Co., with the co-operation of the development and Research department and that of The Chesapeake and Potomac Telephone Co. and the Western Electric Co.

J. G. Truesdell, supervisor of telephone layout and transmission, was in charge of the installation and operation for the Long Lines department. G. K. Thompson, personal representative of Vice-President J. J. Carty, and A. B. Clark had charge of the development work involved, with the co-operation of H. A. Frederick of the Western Electric Co.

The inaugural stand was designed by the Long Lines department and built under the direction of the C. & P. The installation of the equipment was also done by the C. and P. under the direction of G. L. Weller of the Engineering department.

Among those who helped to make the demonstration a success, in addition to those already mentioned, are the following:

F. J. Ward, J. M. Leonard, J. P. Maloy, J. Sehfuss, R. H. Ross, C. W. Owen, J. F. Steel, W. D. Pomeroy, all of the American Telephone and Telegraph Co; H. L. Barkley, C. L. Garrett, L. A. Kershner, H. Scharnikow, J. B. Riley, G. Gray, F. Poynton, C. S. Hedrick, J. V. Hoffman, O. Solomon, W. W. Ebert, J. B. Sweeney, E. F. Schmidt of The Chesapeake and Potomac Telephone Co., and F. A. Hubbard, F. W. McKowan, D. S. Blattner of the Western Electric Co.

On the night of the inauguration the men who had worked so faithfully were given a dinner at the Columbia Country Club, and it proved an affair long to be remembered. Speeches were made by E. K. Hall, vice-president of the American Telephone and Telegraph Company; President A. E. Berry, Vice-President Buehler, General Manager Stryker, Executive Assistant Godwin of the C. and P., and G. L. Weller of the Engineering department of the same company, and Messrs. Thompson, Truesdell, Frederick and Pomeroy of the A. T. and T."

Plant Tours for Good Will

Playing on the same trait that makes the youngster take the clock apart to see what makes the hands go round, is proving a profitable move for telephone companies.

To give the public an intelligent and substantially founded appreciation of the telephone company's intricate operations, holding open house in the exchange has attained a well deserved popularity. Particularly in the case of new exchanges is the open house idea being capitalized. One of the recent cases where a trip through the new exchange put the telephone company "in solid" with its constituency, is that at Middletown, N. Y.

F. D. Fancher, general manager of the Orange County Telephone Co., owners of the new Middletown exchange, invited his subscribers to look over the new lay-out. A full house responded to the invitation, and Middletown telephone service took on a new and more intimate aspect. Mr. Fancher is no amateur as a press agent, so he was alert to tip off the local newspapers to the story in the opening of the exchange. This piece of work pulled a three column illustrated story, and a highly complimentary editorial.

Invites Chamber of Commerce.

Sedalia, Mo., too, has a telephone manager who leaps at the public reception opportunity for effective advertising. A local newspaper ran a query: "Do You Know Sedalia?" and called attention to the city's interesting spots. Manager M. H. Bryan of the Bell Telephone Co. got busy, following up this lead, and invited the Sedalia Chamber of Commerce and other interested business men to visit the telephone plant, giving them a personally conducted tour through the exchange.

Through the public receptions and their news mention, the telephone company gets free advertising, as valuable as any good hard cash can buy. Take this case at Lockhart, Texas. Here the Southwestern Telephone Co., held open house. A newspaper of wide circulation in that vicinity, far from missing a chance to boost its city, runs this line in its story: "Lockhart enjoys a splendid telephone system."

Welcomes Newspaper Men.

There may be practical difficulties that prevent throwing the plant open to public inspection. Then the thing to do is to invite the newspaper men in, so they'll have an insight into your side of the case. After they've given the works an inspection, they'll realize you are "regular fellers" after all, and doing your level best to please everybody.

As an example of the way this party of the newspaper boys works out, we quote from a New Jersey daily:

Telephone Company Entertains Press.

"On invitation of the New York Telephone Co. the editors of many of the papers of New Jersey were entertained by that company. Fifty scribes, with capable guides, inspected the immense building, viewing the various departments, which included the school for operators, the medical offices, where the employes are treated by the company doctors, the big dynamos for the immense power to run the plant and service, and the great number of conduits run into the basements for the transmission of the service, the counting room, the lunch rooms and the operating room, where there were more girls hard at work than any editor thought lived in New Jersey anyway, and who were so busy that everyone of the editors got tired of watching them. After looking over the building the scribes were autoed over to the Washington Hotel, and given an excellent chicken lunch.

"The affair was brought to a close by a forceful address by one of the vice-presidents of the company and the exhibition of a moving picture film which showed the numerous activities engaged in the manufacture of all kinds of telephone instruments and needs of the company.

"All of which made many of the editors sit and take notice, with an idea that there was something about the telephone outside of cursing and swearing at it and the operator when quick results were not obtained. It was a very entertaining and instructive trip to everybody who took part in it, and the telephone people displayed themselves as mighty fine hosts."

Field Notes

Tricks of Wire Chief's Trade

"Angels Could Do No More" Than Clever Wire Does Where Resourcefulness Is Biggest Part of Material On Hand — Leaves From a Past-Master's Book

By J. W. Hepner

A few years ago I was transferred to the East Exchange in a suburb of one of our large cities. Its location is not important, as it has now been consolidated with another small exchange.

I found it to be a small North magneto board exchange with three working positions, non-multiple. The equipment was in good condition. There were some four hundred subscribers. Being located in a summer residential district, the summer traffic was quite heavy. While this exchange was magneto, the other two exchanges—Stillwell and Anderson—between East and the Main exchange were central energy. The trunks were one-way to main, but two-way to the other exchanges.

Greeted With Recall Complaint.

One of the first things I noticed was that the chief operator had considerable difficulty with complaints of her sub-

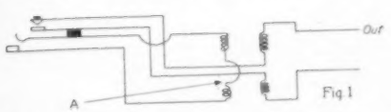


Fig. 1.—Condenser at A, and Jumper Removal Ended Recall Kicks.

scribers who were unable to recall the operator when making a call to one of the other exchanges.

On examining the trunk circuit I found there was a repeating coil cut across the circuit. The resistance was about 200 ohms on a side. This shunted sufficient current so the ring-off drop did not operate. Removing the jumper and inserting a condenser at A (Fig. 1) cured the recall complaints when a subscriber was connected to a trunk.

Ending Battery Grief.

Here I was soon initiated into the cares and worries of a set of crowfoot or gravity cells. In the morning we had no difficulty with the transmission on the order wires, but toward evening transmission became faint. The subscribers also would complain of not hearing the operator. Then occasionally the position would go dead; that meant a trip from the Stillwell exchange, of which I had the care. After getting my hands sore from the effects of the copper sulphate, I started a plan that I had been thinking of for some time—that of putting the transmitters on a small set of storage cells.

Receiving the approval of the superintendent of exchanges, I commenced to make the change. As a working basis I took the circuit that we used in the 24-volt exchange. In place of the 200-ohm coil I used a 100-ohm relay coil; in place of 24 volts used 10 volts, a set of five small B. T. storage cells.

To get current to charge the cells, we wired two of the trunks from Stillwell exchange through a 4-pole double-throw switch at each exchange.

One side of the switch was connected to the exchange battery at the Stillwell exchange. At the East exchange one side was connected to the small battery. The battery was grounded.

The night operator here would throw her switch when taking her position; this would cause the trunks to become permanents. At this signal the Stillwell operator would throw her switch. In the morning the operation was reversed, the trunks being returned to service.

In our efforts to insure continuous service during storms, we took one trunk in one cable and the other in another cable which went by a different way, it being hardly probably that both cables would go out at the same time. We also kept a set of dry cells wired up to take the place of the storage for an emergency measure. This solved the problem of transmission over the order wire especially. The time spent in caring for the gravity cells was clear time.

For the first few days after cutting over the new system we met decided dissatisfaction on the part of the operators. The old system was faint and did not give any noticeable side tone. A few days later, when a position was switched back to the old way while wiring the circuit in permanently, the operators were glad to get back to the new way.

The incoming order wire from the main exchange came through the two branch exchanges whose trunks were two-way. The fact of being two-way often caused complaints from the subscribers. Two operators would have connections up at the same time; one subscriber getting rung in the ear; neither party getting whom they wanted.

This being the only exchange in which the calling operator rang the subscriber, the operator would put up a connection and not ring. In other ways the trunks showed up the service.

At the Stillwell exchange I connected one of the order wire buttons at the operators' positions to the through order wire. This speeded up the service and kept the trunks clear of dead connections.

Seeing how well it worked between these two exchanges, permission was obtained to have the wire chief at Anderson to connect up a similar set of buttons to the through order wire.

Caring for Prosperity.

During the summer the traffic between East and Stillwell often caused "overflow" to be given out. The chief opera-

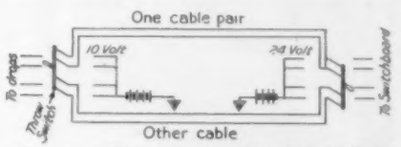


Fig. 2. — Hepner's Cure for His Battery Trouble.

tors then were unable to communicate with each other in regard to some traffic questions that needed prompt attention. This condition caused unnecessary trips from Stillwell. The interurbans ran every hour in the winter. Had I been able to reach this exchange before car time, the chief operator could have cleared the trouble temporarily.

We could see the necessity of a direct line, but the superintendent could not see the two miles of wire to join the cables. For years there had been talk of consolidating the two exchanges. The question was how to get the circuit without expense.

The lines of the two exchanges overlapped. In the lead working out of Stillwell were a couple of partly filled circuits, while from the cable of this exchange extended a line to the office of a real estate agency. This line had not been cut over on account of a real estate boom in that section. The circuit extended almost the entire distance between the boxes.

The inspector asked the agent how he would like to get rid of his magneto. He said that it would suit him, although his number would be changed.

Just before the new directory was issued we obtained the necessary orders to make the cuts we needed. Some partly filled lines were filled. With a few words to the line foreman, we had our direct private trunk line. The chief operator gladly handled the troubles of

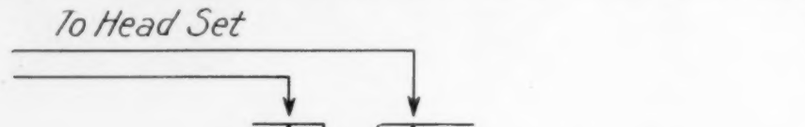


Fig. 3.—A Kink from His Home-Made Test Table.

changed numbers for the convenience of direct service between the boards at all times. So far so good, but it was not good enough. The use of any blessing always opens up to you visions of opportunities of increased improvements.

We removed the drop coil of the line it came in on, and multiplied an extension to the chief operator's and wire chief's desk. A bell box without gongs was bridged across for signaling.

A plug was wired to the secondary of the chief operator's set. With the plug she could answer direct. If the chief was not present the A operator would answer. Then another leg was taken; this ended in a cord at the last position, which gave me a test cord from the Stillwell exchange. An order wire button on my test table at the Stillwell exchange was connected to the through O. W. I was now in a position to render considerable aid to the inspector; also, could furnish howler service. The condenser in the chief operator's ringer always showed the test line was O. K. to this exchange.

Between the chief operator's plug and the secondary there later was placed a ringing-listening key. Another jack which ended in a plug at the board was placed on her desk. This way she was able to call the parties herself, afterwards having the operator complete the circuit at the board.

A Pinch Hitting Test Table.

One improvement that was first suggested was a test table. The foundation of our test table was an old kitchen table that I guess was about as old as the exchange.

We were fortunate in getting an old two-way voltmeter which had been relieved at another exchange. A bank of ten series jacks was dug up from the relic room.

For battery I used the dry cells of the pole changer. The cells were set around on a broad shelf. We rearranged the cells on three narrow shelves so that at a glance any bad cell could be easily noticed or tested. One cell of high resistance soon causes trouble with the ringing. By placing a shunt on the voltmeter the readings were brought within the range of the scale.

A ringing-listening key was obtained.

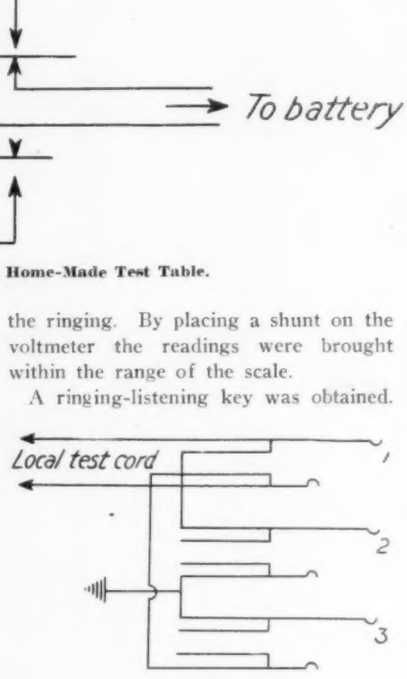


Fig. 4.—How the Jacks Lined Up.

The battery and voltmeter were connected in series to the inside springs of the ringing key (see Fig. 3). A short cord and plug were connected along springs of the listening key. When the key was normal it was used as a test cord.

From the drawing (Fig. 4) you will see how we used the strip of jacks. Jack No. 1 was connected to a plug at the board. No. 2 and No. 3 were grounded on opposite sides. The remaining sides were tapped to No. 1, which gave us a ground test on both sides of the line. No. 4 was shorted, which gave the voltage reading and indicated the state of the ringing battery.

From No. 5 and No. 6, wires were run to the office terminal head. Two sets of springs were so placed that the plug could take the place of the heat coils, giving a means of testing the line in or out and leaving the line in service. No. 7 was the jack, shown in the figure, of the direct line to the other exchange.

Jacks No. 8 and No. 10 were direct lines to the board. The inside springs were strapped to the outside springs of No. 9. This was especially useful when a subscriber of some other exchange was getting a D. A. Getting the subscriber on the other line, I could get in on No. 9 and see that they were talking. An order wire to the board was also installed.

Keeping the C. O. Busy.

As the inspector and myself had Stillwell exchange also to take care of, it was not always possible for both to be here at the same time. Sometimes a cable or drop would go bad. To care for this a vacant number, 320, was wired to a pair of clips on the cable side of the frame. The chief operator gladly learned how to find the cable pairs; when necessary she would snap the clips to the cable lugs. The line would be working through 320 until I could get her to make the needed changes. It came in very handy when the line wagon came unexpectedly with orders for a new line.

Western Electric Holds Show to Broaden Workers' Views.

Chicago, Ill. — Thousands of Western Electric employes and their families visited the annual Products Show staged by the company at its Hawthorne plant. Every type of machinery used in the plant, and each product manufactured there is displayed in pieces, partially assembled, and then fully assembled and explained by demonstrators. The purpose of the exhibit is to show the 20,000 workers spread about the plant's 75 acres, the broad scope and purpose of the work in which they are vital units.

Safety in Rhyme and Reason

Steering a Safe Course Through Perils of the Construction Campaign — Injuries That Befall the Unwary — What to Do When Injured

In the rush of summer construction work there comes a sharp rise in the accident curve of telephone companies. Employes' benefit funds get a sharp jab and the mark of the careless lineman's climber is detected on the furniture placed just this side of the Pearly Gates.

Without eternal vigilance the most adept fall victims. Telephone authorities have made careful studies of the most common of the accidents. These mishaps occur almost every day, just because someone had a moment of forgetfulness. As a particularly timely reminder TELEPHONE ENGINEER prints safety suggestions from the pens of studious observers of numerous telephone accidents.

Those who are reminded of the ever-present dangers and exercise special caution in their presence are indebted for the following suggestions to V. C. Frazell, of the Northwestern Bell, and Frank D. Berry, of the Illinois Bell Telephone Co. Thad H. Snyder, of the Bell Telephone News, is the bard who sings the requiems and near-requiems for the unwary.

Mr. Frazell and Mr. Snyder cite these incidents:

A truck was being pulled out of the mud by a wench line which was run back to a pole in the rear of the truck and fastened around the pole with a skid chain. A district foreman was standing near the pole when the chain broke and the end whipped around the foreman's ankle, crushing the bone.

A lineman went up a pole to loosen some wires which were caught in a tree. He slipped and fell, fracturing his skull.

A construction foreman was standing too near the small coil of messenger which was being payed out. The tie wire came off the end of the coil, which flew up and hit the foreman on the left side of his forehead. His eye was cut.

In using block and tackle
Jim Thompson made a break.
He noticed that the rope was frayed,
But a chance he'd always take.
He gave a heave which was a sin,
The rope then parted with a "bing."
Jim has to use his left arm now—
His right is in a sling.

A truck driver was jacking up a car preparatory to changing a tire. He got under the car to remove the jack, when the weight of the truck forced the handle of the jack up, catching the driver's left wrist and inflicting a fracture.

An installer was burning out a cable. He kicked over a kettle of hot paraffin and badly burned his left ankle.

A groundman slipped while climbing down a pole and gaffed his left foot with the hook.

A lineman's helper was pulling slack in a copper wire when the wire broke and the end struck the man in the left eye.

Between high-tension wires
A lineman worked away;
He sort of grew forgetful
And careless, so they say.
It did no good to warn him,
For he knew much the best
That he was in no danger—
His tombstone reads, "At Rest."

An installer, after parking his car, carried his tools one and one-half blocks to the job, but failed to take his stepladder with him. He used a table to stand on. When the work was completed and he started to step from the table it upset with him and he fell, spraining his left wrist.

A groundman failed to fix his pike firmly in a pole which was being raised and the pike slipped. The pole fell, striking the groundman on the back of his head.

A lineman allowed his safety belt to work over the top of the pole and he fell backward. He struck the roof of a barn and rolled off to the ground, breaking his right kneecap.

A combination man's automobile stalled in a mudhole and the engine stopped. He got out to crank it and the car back-fired, the crank breaking his shoulderblade.

Bill Jones, who always drove a truck
Across the tracks so fast,
Imagined he could get across
Before the train went past.
Well, yes, he did it many times,
In spite of rule and warning;
One day an engine bumped his truck—
Bill's wife is now in mourning.

An installer skinned his hand while tying a wire to a rope on a pole. Later he got a splinter into the wound and infection resulted.

A lineman, wearing his climbers while walking through some brush, stumbled and stabbed himself in the right heel.

A repairman was putting a socket on a wall, his ladder placed behind the door. Someone opened the door, knocked his ladder from under him, and he fell, seriously injuring his back.

While carrying a pole a wire chief didn't watch where he was going and he stepped into a hole, seriously wrenching his back.

There was a man who fancied
That all poles he would climb
Without making an inspection;
"It's just a loss of time."

He would set down a record
And make the linemen sore.
There WAS a man who fancied this—
There isn't any more.

Frank Berry's pertinent suggestions are well worth reprinting. He calls attention to:

LADDERS.

1. Examine all ladders before using.
2. Examine ladders for nails and sharp projections. This also applied to ladders in exchanges.
3. Test your ground support; secure ladder or have someone hold it.
4. Avoid haste in ascending or descending ladder.
5. All stepladders should be properly tied to prevent spreading.
6. When using extension ladders exercise care in raising and lowering extensions.
7. Do not borrow unsafe stepladders.
8. Do not build unsafe scaffolds.
9. Do not stand on chairs or boxes.

POLE WORK.

1. Be sure spurs and straps of climbers are in good condition.
2. Be sure your safety belt is on properly and is in good condition.
3. Be sure you know how to climb pole.
4. While working on pole, be sure your tools are in such condition that they will not fall and strike someone below.

5. Be sure all tools that are used by you are in good condition and that you know how to use them properly.

SCREW DRIVERS.

When using screw drivers be sure the hand nearest the object is not in danger in case screw driver should slip.

2. Do not carry the screw driver or other sharp tools in outside pocket.

First Aid Treatment.

BUT—if the foregoing isn't sufficient to ward off impending danger, and misfortune claims another telephone man, then what Edwin W. Bullock, M. D., tells the Telephone Topics interviewer will be worth heeding.

Dr. Bullock says: There are four symptoms which will let you know when a wound has become poisoned or infected; namely, pain, heat, redness, and swelling.

Never neglect an infected wound; see a doctor at once; have the wound opened, the pus and dirt cleaned out, and have the doctor care for the wound until it is healed.

When treating a wound of any kind we should have one thought constantly in mind, and that is *absolute cleanliness.*

Remember our own skin is covered with pus germs, and when placing a dressing on a wound always be careful not to touch the surface of the wound with your hands, and never let your hands come in contact with any part of the dressing which is going over the wound. If we do, pus germs or dirt from our hands will get on the dressing and into the wound. If possible, wash your hands thoroughly in soap and water before dressing the wound, and be sure you have a clean towel on which to wipe them; if no clean towel is at hand, apply the dressing with your hands wet.

It is a bad plan to hold a wound under running water; you will wash dirt and germs into the wound. Never suck a wound; the mouth is full of deadly pus germs.

With small cuts it is a good plan to squeeze a little blood out of the wound before applying the dressing; this will help to wash dirt germs out of the wound. Remember that there are no germs in the air that will poison a wound, for the oxygen in the air will kill all pus germs, and a wound will not go wrong so long as the air can get to every part of it.

It is better to leave a wound exposed to the air until the doctor comes than to cover it with a dirty dressing.

Do not seal the wound so tight that the air cannot get in. Painting the wound with collodion or covering it with sticking plaster shuts out the air and helps the germs to develop and cause blood poisoning. Collodion or sticking plaster should only be used to hold the dressing in place.

Of the various drugs used on wounds, the tincture of iodine is by all means the best.

Don'ts to Remember.

Do not use iodine in cuts about the eyes.

Do not use iodine too freely in extensive scalp wounds; it may cause trouble. Creolin, a coal tar product, is also used, but is not as good as iodine. It should be diluted in water, about 20 to 30 drops to one pint of water. Lysol is also good, but look out and do not use too strong a solution. Ten drops in one pint of water is strong enough.

I do not advise the use of peroxide of hydrogen on clean wounds. It is of use to clean the pus out of poisoned wounds, and should be diluted in equal parts of water. Do not use any solution of bichloride of mercury (corrosive sublimate) or carbolic acid except on the advice of a doctor. These solutions will often inflame and corrode the edges of the wound and retard healing.

To summarize: Keep the wound clean, paint around the wound with iodine, apply a sterile dressing, bandage or strap with plaster to hold the dressing in place, and then take the man to a doctor for further treatment.

Government Issues New Electrical Safety Code.

Washington, D. C.—United States Bureau of Standards has issued a new edition of the National Electrical Safety Code. This publication contains much of interest to telephone men. It is divided into four parts, rules for the installation and maintenance of electrical supply stations and equipment, rules for the installation and maintenance of overhead and underground electrical supply and signal lines, rules for the installation and maintenance of electrical utilization equipment, and rules to be observed in the operation of electrical equipment and lines. Copies of this code may be obtained from Superintendent of Documents, Government Printing Office, Washington. The price is 40 cents.

Cables Cross. May Set Value of Lineman.

What's the value of a lineman? This query may soon be decided in a North Carolina court. A telephone lineman, victim of an accidental cross between a telephone and electric cable, sets his worth at $50,000, and has entered suit to collect.

POLICE WIRELESS.

Chicago Police Try Wireless Telephones in Battling Crime.

Chicago, Ill.—Commissioner of Gas and Electricity Keith, after a conference with Lee DeForest and B. E. Cover, announces wireless telephone transmission apparatus capable of sending 1,000 miles will be installed at the City Hall.

Receiving sets will be installed on two fire boats, two lake cribs, two police stations, a fire alarm office, two patrol wagons, and two of the fast pursuit automobiles operating out of the detective bureau.

Amplifiers will be installed at the receiving stations so the voice of the headquarters speaker may be heard even above the noise of a speeding automobile.

The police authorities are anxiously watching the tests, hoping for developments that will relieve the present strain on the police and fire alarm systems. If the trial is successful, the wireless telephone equipment of the Chicago police force will be greatly extended.

This the Meat Market? Fido Smith Is Calling.

Boston, Mass.—Being duly sworn and properly impressed with the lofty nature of his truthful profession, a Boston reporter writes this for his sheet:

"Not far from Boston lives a dog by the name of Timbuctoo, a dog which has never been trained, but which of its own accord acquired a 'trick' which besides being clever is decidedly helpful. His home is on a farm, which is served by a seven-party telephone line. The call at Timbuctoo's house is five bells, or as the operator would say, 'ring five.' Wherever his mistress is when the telephone rings five times Timbuctoo will go to her and give five short, sharp barks.

"He has never been known to make a mistake either by barking more or less than five barks, or by calling his mistress when the bell rings some other call."

Kansas to Have Statewide Telephone Survey by Commission.

Topeka, Kan.—Jess W. Greenleaf of the Public Service Commission plans an exhaustive survey of telephone conditions in the state.

NEWS FROM FOREIGN LINES

Swedish Automatic System Gets Rotterdam Order.

Stockholm, Sweden.—After experiments covering eight years the L. M. Ericsson Tel. Co. announces its Hultman-Ericsson automatic telephone system is a practical success. The Ericsson organization is credited with several large orders for this equipment, among them being a 5,000 subscriber exchange at Rotterdam, Holland.

Howler On? No; Chinese Music Via Telephone.

Peking, China.—C. H. Minor, manager of the Western Electric's far eastern subsidiary, has installed in the skating rink of the Peking Club loud speaking telephones of the same type as those used at President Harding's inauguration. This device is put to a severe and steady strain in carrying Chinese jazz music from a phonograph in the club's basement to the popular skating rink, which is patronized by the Celestial City's four hundred.

Italian Telephone Salesmen Getting Business.

Milan, Italy.—One of the most active industrial organizations in Milan is that of Ettore Fiocchi & Co. This company continues to do a brisk business despite unsettled industrial conditions prevailing generally in Italy. It recently issued an attractive brochure illustrating representative installations made for prominent Italian institutions.

Japan Spending Forty Million Yen on Telephones.

Tokio, Japan.—A two years' campaign of underground cable work connecting the principal cities of Japan, has been inaugurated. Cost of the work is estimated at 60,000 yen a mile. Forty million yen is to be spent in extending and improving telephone service, according to reliable sources.

London Can't Wait for New Automatic System.

London, England.—Unable to endure longer the congestion which has grown rapidly pending the installation of automatic exchanges in London, the postoffice is providing new manual exchanges. One of the latest small relief exchanges is being put into operation to care for about 2,000 subscribers in the Mayfair exchange district.

TELEPHONE PROGRESS.

J. H. Bell, Western Electric Engineer, Reports Telephonic Development Abroad.

New York, N. Y.—J. H. Bell of the Western Electric engineering force, who has returned from a nine months' investigating tour of Europe's communicating facilities says:

"Sweden is installing a huge underground telephone cable system which will be second in length only to the line now operating between Boston and Washington. The material is being manufactured by the Western Electric Co. at Chicago. Great Britain, Holland and Norway are reorganizing their telephone systems to provide for the introduction of machine switching methods similar to those now proposed for use in the United States. The first two nations also are installing underground cables for toll purposes. Italy is busy on plans to connect its more important cities by toll cables. Automatic exchanges are also being considered. French lines of communication in the battle area and elsewhere are to be reorganized on a plane far better than that of pre-war days."

Scotch "Are You There" Lass Honored by King.

Glasgow, Scotland.—Miss May Bannerman, mentioned by Field Marshal Haig for "gallant and distinguished service in the field," has been decorated by King George for her three years' valiant work.

Planes Catch Phone Calls 200 Miles Away.

London, England.—According to an official air ministry announcement airplanes equipped with wireless telephones are getting messages that originate 200 miles distant. Radiophone stations for sending weather bulletins to fliers, have been completed. There are six in England, two in France and one each in Holland and Belgium.

Street Corner Phones to Boost Revenue.

London, Eng.—Every street corner in London will have a public telephone station if parliament adopts a proposal recently made to it as part of the plan for extending the British telephone system, and increasing its revenue.

Nippon Maids Leave Boards for Husbands.

Tokio, Japan.—This is the year of the bird in Japan. According to tradition it's a good year for the young ladies to get husbands. Naturally it is also a bird of a year for scarcity of telephone operators, according to reliable reports.

Italian War Telephone Work Presented Historically.

Rome, Italy.—Telegrafi E Telefoni for January presents a thorough review of the telephone's work in the field during the war. The telephone's vital part in the campaign, details of methods employed, and the military results achieved by the Italian field telephone service, are covered in detail.

India Building Long Distance Lines.

Bombay, India.—Considerable telephone work is being done in India this year. The government telephone line between Bombay and Surat has been opened. Other long distance lines connecting principal Indian cities are being constructed.

German Telephone System Is "In Bad."

Berlin, Ger.—Before the Reichsbund deutscher Tichnik (German Technical Union), Dr. H. Bredow outlined the financial position of the German telegraph and telephone service (2,000 million marks deficit in 1920), and suggested remedies for improving the position. The large deficit is due to the extraordinary rise in the cost of materials and labor; the prices for iron wire have increased 3,000 percent; for copper wire 1,200 percent; for underground cable, 2,000 percent; cable and flexible for internal connections, 3,000 to 4,000 percent; and telephones, 2,000 to 3,000 percent. Both systems are at present strained to their highest possible capacity, and extensions must be undertaken at once. Prior to the war, the cost of a telephone line in Berlin was Mk. 800, and is now Mk. 11,000, while the cost of working and maintaining a line has increased tenfold. Although the telephone fees have increased to about four times the pre-war rates, further drastic alterations are contemplated. The unlimited service rate will be abolished. The cost of installing telephones has already been increased,

Rochester, Minn. Cut-Over

Advent of Automatic Operation in City Made Famous by Mayo Surgeons Featured by Another Classic Cutting Job—Details of Modern Plant

By H. E. Clapham

At midnight, April 16, in the presence of a number of other city officials, local telephone experts, and out-of-town visitors, Mayor C. D. Brown of Rochester, Minn., threw a switch in the Rochester Telephone Co.'s new building, giving the signal for the cut-over of a new Strowger Automatic switchboard serving some 3,500 stations.

To accommodate the new equipment a handsome new building has been erected. The structure has a red brick front, is fireproof throughout, and consists of two stories and a basement. The back of the lot on which it stands is vacant, so that any time the telephone development of the district makes it desirable, an addition will present no difficulties.

The second floor of the building contains the automatic switchboard, test desk, main frame and power board. Although the equipment installed has a capacity of 2,160 lines, large enough to meet the requirements for some time to come, there is still space enough for the installation of more than 200 additional lines, as well as for a group of secondary line switches which, it is probable, it will eventually become advisable to install.

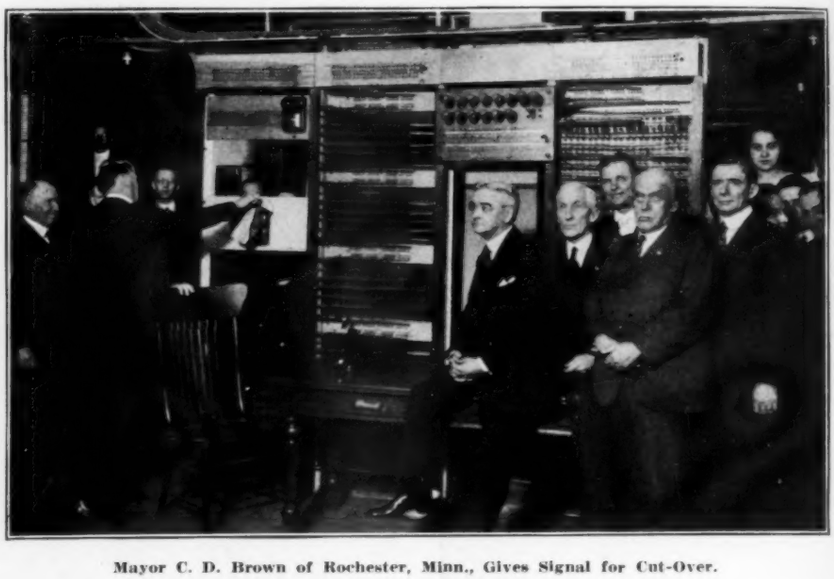
The first floor contains the offices of the company, operators' rest room, a two-position information desk, and an eight-position toll board, through which calls are made to St. Paul, Winona, and other long distance points.

For many weeks previous to the cut-over the local engineering staff and switchmen had been at work in the company's new two-story building, installing and testing the equipment ready for service. The greater part of the subscribers' line cables leading to the old manual offices were half tapped to the new main distributing frame, while the remainder were led directly to the new main frame and from there temporarily jumpered to the old office. The automatic equipment was temporarily disconnected from the subscribers' lines by inserting toothpick wedges in the cut-off relays of the line switches.

As the signal for the cut-over was given, the jumper cables were cut at the new M. D. F., the heat coils were removed from the M. D. F. at the old exchange, and the toothpick wedges removed from the line switches, permitting the traffic to flow into the new equipment.

Sit Up to Try Service.

For one or two hours after the time of the cut-over, the traffic was much above normal for that time of day, many subscribers sitting up to try the new service. Owing to the excellent condition of the outside plant upon which a great deal of money has been expended recently, no difficulty was experienced.



Mayor C. D. Brown of Rochester, Minn., Gives Signal for Cut-Over.

The automatic switchboard installed in the Rochester exchange is of the 10,000 line type, with an installed capacity of 2,160 lines. One thousand of these are single lines, including parts of the 2,000 and 3,000 line groups.

Equipment for 700 four-party lines, using harmonic signaling has been installed, and is at present serving some 1,750 stations. Equipment has also been provided for 300 two-party harmonic lines serving at present about 350 stations. The 1,000 party lines are distributed among the 5,000, 6,000, 7,000 and 8,000 groups.

A special rotary unit has also been installed for automatic trunk selection to private branch exchanges. This unit also contains the connector terminals of a number of pay-station lines, so that calls to a pay station may be set up by the pay station clerk's dial at the toll board. Calls originated at a pay station are received manually at the toll board, where an operator sets up connections to local stations by means of the dial.

The usual provisions have been made for handling calls to special service desks. Special service calls are trunked through the first level of first selectors to a group of special second selectors. The tenth level trunks of these selectors are led to a group of special third selectors, the trunks from the various levels of which are led to the proper desks or switches.

An interesting feature of this scheme is that although each special service number consists of four digits, only three groups of switches are used, the special third selectors being designed to drop back from the tenth level when the third "O" is dialed.

Avoids Changed Number Confusion.

One object of this is to permit the special service numbers to be the same as those of the exchanges of the Tri-State Telephone & Telegraph Co. at St. Paul, so that visitors from one city to the other will not be confused by a change in numbering. To reach the in-

formation operator, subscribers are instructed to dial 1004, repair, or complaints 1007, service operator 1000, and long distance 1005.

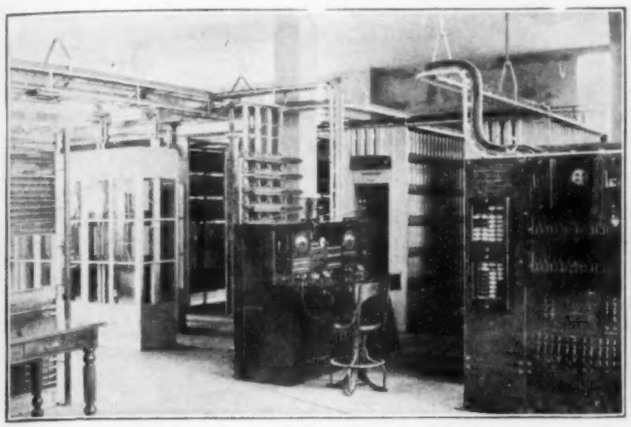
Besides the 2,100 local lines, the Rochester Telephone Co. operates about sixty rural lines, serving the outlying farms and villages. Having been accustomed to code ringing from the manual board, it was decided to use the same system of signaling with the automatic equipment.

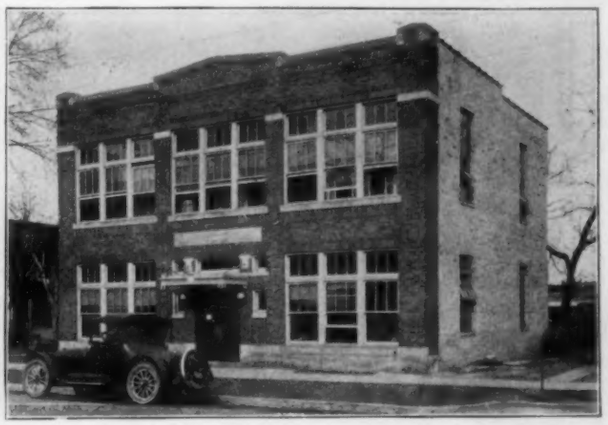
repeater to standardize impulses to the regular exchange equipment.

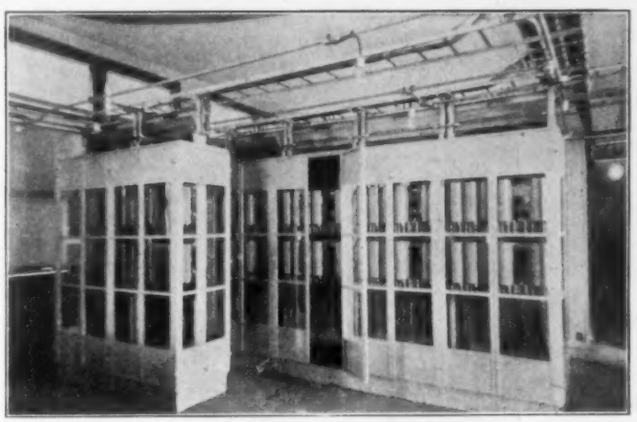
For reverting calls on city party lines, a group of reverting call connectors have been installed, which are reached by dialing 19. On the transmitter at each party line station is mounted a card giving the directory numbers of the remaining stations on that line and the proper reverting call numbers to be used to reach each one. After dialing such a number, the call-

and to the excellent publicity campaign conducted in the local newspapers for about a month preceding the event.

This campaign, which was directed jointly by G. F. Beatty, district commercial superintendent of the Tri-State Telephone & Telegraph Co. (which owns the Rochester Telephone Co.) and T. H. Considine, manager of the Rochester Co., was one of the most extensive and successful of its kind ever conducted. The campaign not only included de-







Above—Switchroom, Showing Test Desk, I. D. F., and Power Board.

Right—Line Switch Units; Connector Side.

Above — Rochester's New Exchange Building, a Handsome Structure Housing Automatic Equipment That Serves 3,500.

To enable the calling subscriber to send out a definite code signal on a rural line, each connector serving the rural line group has associated with it a selector and a code interrupter. The code interrupter generates and groups the code signals, and the code selector, operated by two additional digits in each rural numbers, selects the proper combination and starts the ringing. Since any of the rural connectors may be reached by dialing a common code (24) the six-figure rural code numbers are just as easy to carry in mind as the four-figure city numbers.

Since the traffic originating on the rural lines is rather heavy, and the lines more heavily loaded than the city lines, each line terminates in a selector repeater, which serves not only as an individual first selector, but also as a

ing subscriber hangs up, upon which both his bell and the bell of the desired station begin to ring alternately and intermittently, until the call is answered. If the call is not answered, the ringing may be stopped by the calling subscriber removing his receiver for an instant.

Reverting calls on rural lines are handled in a very similar way. By dialing a certain code, a rural subscriber is connected to a code selector which is especially designed to ring back on the originating line.

Making Cut-over Smooth.

The smoothness of the cut-over and the absence of any serious irregularities in the service after midnight was largely due to the foresight of the local staff who arranged the cut-over procedure,

tailed printed instructions concerning the operation of the dial for both local and rural subscribers, but practical demonstrations were given daily at the Rochester Civic and Commercial Association. Included in the newspaper campaign were interesting stories of the origin and growth of the Strowger Automatic system.

Since it was necessary to change practically every call number in the system, new directories were issued a short time previous to the cut-over. A novel feature of this directory was the sealing of the pages until the hour of the cut-over. While it is doubtful if many obeyed these instructions, the fact that they were so prominently displayed caused the subscribers to be more careful in using the correct call number.

Because of its numerous medical in-

stitutions, Rochester has always had an enormous transient population, and its ability to care for this in a very adequate manner is one of its many claims to distinction.

Its telephone development, too, has long been recognized as unusually extensive. Associating with this development a thoroughly modern telephone service, Rochester may be justly proud of the latest addition to its many civic advantages.

Present at 'Witching Hour.

Naturally the event of the cut-over was of prime inteerst to the local telephone men and city officials. Among those who attended the midnight function were Mayor C. D. Brown, Rochester; A. F. Wright, city clerk; Wm. McDermott, chief of police; Dr. Chas. Mayo and T. H. Considine, manager of the Rochester Telephone Co.

Among the out-of-town visitors were a number of officials of the Tri-State Telephone & Telegraph Co., from St. Paul, including C. B. Randall, secretary and attorney; G. K. Gann, general superintendent; A. J. Seymour, chief engineer; A. C. Cragg, general auditor; W. J. Howard, traffic superintendent; O. Knell, plant superintendent; A. C. Brokaw, advertising manager; G. F. Beatty, district commercial superintendent, and J. Belliveau, district manager.

Other out-of-town visitors included P. M. Ferguson, manager Mankato Telephone Co.; C. M. Smallwood, manager Worthington Telephone Co.; Chas. Webb, manager Byron Telephone Co.; W. S. Vivian, manager traffic and service development department, Automatic Electric Co.; F. G. Donnelly and F. Hemsted, installation department, of Northern Electric Co., Montreal; Fred Baer, contract sales engineer, and James Engh, operating department, Automatic Electric Co.

Builds Special Lockers for Telephone Companies.

Aurora, Ill.—The Lyon Metallic Mfg. Co., with the assistance of telephone engineers, has designed a special line of steel lockers, shelving and cabinets for telephone company use. This new line is featured in a recently published catalog which illustrates and describes steel compartment lockers, head set cabinets, repair parts cabinet, line cabinets, shelving for exchange storerooms, cloakroom and workshop equipment.

Million Phones Involved in Ohio Merger.

Cleveland, O.—A million telephones, 1,000 exchanges and 550 telephone companies are involved in the Ohio Bell and Ohio State merger. The united interests will be incorporated for $100,000,000.

CABLE "SHIMMY" DAMPER.

Southwestern's Engineers Invent Vibration Cure for Bridge Cables.

St. Louis, Mo.—Vibration of the big McKinley bridge, connecting St. Louis and East St. Louis already has crystallized one cable. The Southwestern's telephone engineers are not the men to keep feeding cable to the bridge as a partner in its mad dance, and here's the way the destructive vibration was overcome, as told in the Southwestern Telephone News:

"Vibration on the bridge proper was eliminated by catenary construction, the cable being suspended from a messenger in the usual manner. This messenger was supported from a catenary messenger by vertical strands. The catenary messenger was attached over the piers where there was little or no vibration. However, at both ends the cable still remained attached to the roadway guards where was vibration.

"The larger picture herewith shows how a cure was obtained. Springs were used to support the cable, and these springs absorbed all vibration, leaving the cable hanging stationary.

"First, the average weight each spring would be required to support was estimated. Then some sample springs were made and placed. Buckets of water were hung from them, and experiment conducted until the vibration of the bridge failed to disturb the water. When this was done springs of required strength and temper were ordered.

This Device Prevents Bridge Expansion Snapping Cable.

Cable Suspension Springs.

"Note the springs were used in pairs. It was found that one spring strong enough to support the required weight did not have sufficient give to absorb the vibration, so two lighter springs with more give were used.

"The smaller picture shows the construction used to keep the expansion of the bridge from snapping the messenger. The bridge contracts and expands in a different ratio to the messenger. The messenger, therefore, is rested on the support and slides freely back and forth so that it is independent of any expansion or construction in the spans of the bridge."

Seeks Woodpecker Protection for Poles.

Dallas, Tex.—E. M. Hankins, toll plant engineer of the Southwestern Bell, has resolved to make telephone poles an unhealthy banquet board for woodpeckers. He has tried creosote, and the birds grew fatter and slicker than ever. He plugged holes with concrete, and that didn't stop the redheads. Now the matter has reached the stage where Hankins and his men have taken it to heart, so the outlook is distinctly unhealthy for the woodpeckers.

English Lightships Get Wireless Phones.

Liverpool, Eng.—Bar Lightship and the Liverpool dock offices now are kept in touch with a wireless telephone installation, the first of its kind in English shipping circles. Operation on a short wave length and great selectivity is conducted because of the importance of preventing interference by other marine wireless traffic.

Tree Trimmer or Butcher?

Handling This Job Right Improves Service and Public Relations—One Man Studies Trees So His Company Stands Higher With Public

There is a sharp line dividing the tree trimmer from the tree butcher. The tree trimmer is a master of a fine art, too frequently slighted and, in its neglect, blasting good will that has been acquired by the intelligent and costly work of all but the man who ruthlessly and carelessly cuts.

As an indication of the damage the tree butcher can do his company, we quote from an editorial in the Chicago Journal of Commerce, headed "Tree Butchery. This publication says:

"Telephone men play havoc with the trees in the smaller cities when they interfere with the wires. They have 'topped' row after row of majestic growths—that is, sawed off, like the top of a chess castle, all the big limbs as high or higher than the wires, leaving a stubbed, ugly, barren top in painful contrast to the tree's natural beauty.

"Beware the man who comes to the door offering to trim free the shade trees along your sidewalk. He has only their mutilation in his mind, and at this season is more than willing to destroy thousands of dollars in tree values to save his company hundreds in cables enclosing the wires."

One of the masters of tree trimming is G. R. Brackett of Duluth. When Brackett's suggestions are followed the telephone company and the tree owner may live together in peace and brotherly love. Some of his tips on tree trimming, as given to the Northwestern Bell men in a valuable series, follow:

The most rapid healing on a tree is at the sides of a wound. This is because the sap on its downward flow will find its way to the margins of the living bark if there are no obstructions, and thus will quickly supply the tree food needed to heal. For this reason it is important to make the cut that offers the least resistance to the growth of the callus in healing a tree wound.

When a limb is cut too far from the trunk it is impossible for the callus to heal the wound until the stub decays and falls. These stubs are ideal places for boring insects and disease-producing fungi to start their destructive work.

In pruning a tree it is of great importance that the cut be made right. A careful study of Fig. 1 will give the best idea of how this is done.

Nothing suggests extreme carelessness or ignorance in pruning more than to see bark stripped from the tree at the lower side of a cut. This can be prevented by tying a rope where the cut is being made.

When trimming always start at the top of a tree. This will enable you to follow a definite plan and maintain the symmetry of the tree. You can also clear the lower branches of the limbs which have been removed, thus saving time and labor.

The time to prune is more or less governed by the kind of tree to be pruned. Ordinarily the winter or early spring

Fig. 1—Correct and incorrect methods of making a cut. Start the saw at A, sighting from above so that the back of the saw appears as a straight line hiding the sides and the line AB. Now make the cut without letting the saw vary from this plane. A slight tilt of the saw blade at the start may cause the cut to follow the lines AC or AD. In starting the cut from the bottom it is of greater importance to start right, or the cut may follow the lines BE or BF instead of BA. The white lines on the upper stub show cuts made too far out, too far in, and the correct cut between. The middle cut will heal the quickest.

is the best time, when the tree is dormant. It is much easier to shape a tree when the foliage is on it, and it is also easier to discover dead limbs at that time. It may be said that any time after midsummer is a good time for pruning.

During May, or any time in the spring or early summer, the sap is most active and may flow too freely from wounds. The bark is easily stripped from trees at this time.

Guying to trees, even under the most advantageous conditions, is not very practical and should be avoided when any other method of guying is possible.

The trunk and limbs of a tree have great tensile strength; that is, they are flexible to a marked degree. You can easily image the great strain that is brought to bear against the trunk of a huge, spreading, thickly foliaged tree during a severe wind storm. The limbs bend and swing as though in the grasp of a giant, and then spring back into place without any material damage to the tree. This bending and swinging is distributed to every part of the tree from the ground to the smallest branch at the top, but the main strain is against the trunk.

When we place a guy on a tree the flexibility of the tree is destroyed from the point at which the guy is attached to the base of the tree. The strain that this part of the trunk took care of is distributed to the upper or weaker part of the tree. The tree constantly swaying will also cause the pole to which the guy is attached to sway, and this motion will be transmitted to the wires for a considerable distance in each direction on the lead and in some cases may cause the wire to break or swing crossed.

Sometimes we find it necessary to guy to a tree regardless of these conditions. When this is necessary it is best that that the guy be placed so that there will be the least chance for damage to the tree or to our lead.

A through eye-bolt will only make a small wound that is rapidly covered, with no serious complications resulting. Do not guy so the strain on the guy wire may split the tree. The clearance must be ten feet above a sidewalk and eighteen feet above a highway. In putting a bolt through a tree countersink it until the head of the bolt is flush with the bark, then paint it with thick lead paint and the bark will soon cover the bolt and the nut.

Placing the guy wire around the tree, or only half way around, even when wooden slats are used, is harmful to the tree. The strain of the guy is made against the bark at the point of attachment, and this has a choking effect on the very delicate cambium layer.

A tree eye-bolt makes a good attachment when the strain is not too severe.

Care should be taken when installing these so as to not split the tree. Do not use them where the strain is too great or the bolt will either pull out or split the limb.

When cutting down a tree there are two methods to follow. If you want the stump to sprout, cut it low and slanting. If you want the stump to die, cut it high and level, and sprinkle a little common salt around the base of the stump.

Remember these suggestions:

Don't consider tree trimming as a job to get off your hands quickly, regardless of the health of the tree or the owners' wishes.

Do not leave the brush under the tree after trimming.

When trimming the tree to clear wires do not be satisfied with just removing the limbs that are in contact with or interfering with the wires. Trim the whole tree if it needs it and make it a beautiful advertisement of your handiwork as a tree trimmer.

Consider the tree as a living, breathing body, vital to your very existence, and treat it with respect.

Take care of the wounds you inflict and prevent disease from killing the tree. Always paint a wound and help the tree that much.

Follow instructions where trimming and feel the satisfaction of having done a real job.

Use sharp tools.

Clean the tools thoroughly after you have cut into a diseased tree.

BLASTING HOLES.

Explosive Expert Advises N. G. "Fast" Dynamite for Blasting Post Holes.

A DuPont explosive expert says: "I have proven by my own experience that it is practicable to blast post holes in hard or frozen ground with dynamite, but I find it makes a difference what kind of dynamite is used; just 'any old kind' won't do.

"Any kind of dynamite will blast a hole in the ground, but not the kind of a hole a construction foreman wants. A telegraph or telephone pole hole should not be any larger than necessary, and the soil around it should not be loosened up any more than is necessary. If it is, the pole is apt to lean."

"I first tried a "slow" ammonia dynamite for blasting pole holes in shale. It wasn't satisfactory because it made too broad a hole and loosened up the shale too much.

"I then tried a straight N. G. 'fast' dynamite and got just the type of hole needed. The dynamite was loaded in a bore hole put down to within six inches of desired bottom. The charge was not tamped. The fast dynamite blew out a nice vertical hole, having not much more spread than would be made with long-handled shovels. The surrounding soil was not disturbed enough to hurt. The charge used in each hole was one and three-quarter pounds. For hard clay, one pound or even less would doubtless be sufficient. But it is easy to decide on the proper charge after noting the effect of one or two trial shots in the soil in which the blasting is being done.

JEWETT ADVANCED.

Western Electric Chief Engineer Is Promoted to the Vice-Presidency.

F. B. Jewett, chief engineer of the Western Electric Co., one of the best known telephone engineers in the United States, has been elected a vice-president and director of this company. He will

Dr. F. B. Jewett.

continue his present duties in charge of the technical forces of the great telephone manufacturing industry.

Doctor Jewett was a lieutenant colonel in the signal corps during the war, and was decorated with the Distinguished Service Medal. He was born in pasadena, Calif., September 5, 1879. He graduated from the Throop Polytechnic Institute of Pasadena in 1898, with the degree of A. B. in electrical engineering. From 1898 until June, 1902, he was a graduate student in the University of Chicago, receiving the degree of Ph. D. in 1902. The last two years of his post graduate work he was research assistant to Professor Michelson of the department of physics. From 1902 to 1904 Doctor Jewett was instructor in physics and electrical engineering at Massachusetts Institute of Technology.

Doctor Jewett's connection with the commercial telephone world dates from September, 1904, when he became transmission engineer for the American Telephone and Telegraph Co. While acting in this capacity, the loading of eight gauge circuits was perfected; phantom cables and phantom loading for open wires and cables were developed; the New York to Denver circuit and line was engineered and also the Boston to Washington underground cable. In April, 1912. Dr. Jewett became assistant chief engineer of the Western Electric Co., in charge of all development and research work. He has been chief engineer since 1916. Dr. Jewett was an advisory member of the Special Submarine Board of the Navy.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912,

of TELEPHONE ENGINEER, published monthly at Chicago, for April 1, 1921.
State of Illinois, County of Cook, ss.

Before me, a notary public, in and for the state and county aforesaid, personally appeared W. H. Graffis, who, having been duly sworn according to law, deposes and says that he is the general manager of TELEPHONE ENGINEER and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to-wit:

1. That the names and addresses of the publisher, editor, general manager and business manager are:

Publisher, Telephone Engineer, Chicago, Ill.

Editor, H. B. McMeal, Chicago, Ill.

General Manager, W. H. Graffis, Chicago, Ill.

Business Manager, Herbert Graffis, Chicago, Ill.

2. That the owners are (give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 percent or more of the total amount of stock):

W. H. Graffis, Chicago; Herbert Graffis, Chicago; Jos. M. Graffis, Chicago.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are (if there are none, so state):

None.

4. That the two paragraphs next above, giving the names of the owners, stockholders and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholders or security owner appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bonafide owner; and this affiant has no reason to believe that any other person, association or corporation has any interest, direct or indirect, in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date above is . . . . (This information is required from daily publications only).

TELEPHONE ENGINEER,
W. H. Graffis, Gen. Mgr.

Sworn to and subscribed before me this 5th day of April, 1921.

(My commission expires Feb. 2, 1922.)
(Seal) LILLIAN FINCH.

BUSINESS MAKES RATE.

Rates Based on Character of Subscriber's Business in Weston Schedule.

Weston, W. Va.—A "pay as you enter" telephone rate schedule has been worked out by the Peoples United Telephone System, of which M. M. Reger is president. The Weston rate is based upon the class of the subscriber's business, and the average use of service by the particular classes of the company's subscribers has been carefully determined.

The interesting new schedules introduced by the Peoples United Telephone System follow:

Schedule B. Country Service.

I.

(a) For blacksmiths, carpenters, constables, farmers, justices, ministers, shoemakers and cobblers, and stallion owners and keepers, a rate of $12 per year.

(b) For furniture stores, feed and flour mills, hotels, harness and saddle shops, millinery stores, merchants, physicians, veterinary surgeons, licensed undertakers, dealers in automobiles and other vehicles, and garages, a rate of $15 per year.

All subscribers for service under classifications (a) and (b) above may in all cases be required to furnish and keep in good working order phones coming up to the standards prescribed in applicant's by-laws and to make and maintain their connections with the main lines of application, and in cases where applicant under exceptional conditions shall furnish and maintain phones and connecting lines for subscribers who would otherwise come under either of said classifications, such subscribers shall thereupon be placed in their corresponding class under section II of this schedule in respect to rates and phone rentals to be charged.

Service in Incorporated Towns and Cities and Environs.

II.

(a) For farmers, constables, justices, ministers and restaurants, a rate of $15 per year.

(b) For architects, bakers, barber shops, bricklayers, carpenters, harness and saddle shops, masons, milliners, blacksmiths, shoemakers and cobbles, stallion owners and keepers, teamsters and workers for oil and gas companies, and veterinary surgeons, a rate of $16 per year.

(c) For brick manufacturers, carpenters, contractors, newspaper offices, furniture stores, feed and flour mills, hotels, livery barns, marble shops, lawyers, merchants, feed stores, physicians, steam laundries, garages, railroad offices, hospitals, ice manufacturers, electric light companies, plumbing shops, dealers in automobiles and other vehicles, garages, insurance offices, machinists, banks, meat markets, carbon black companies, offices of county officials, druggists, lumber dealers and lumber manufacturers, a rate of $20 per year.

(d) For licensed undertakers, foundry and machine shops, glass factories, oil and gas factories, oil well contractors and coal companies, a rate of $25 per year.

(e) For wholesale houses and brokers, a rate of $46 per year.

Connecting lines for subscribers obtaining this service to be furnished, installed and maintained at applicant's expense, except where such connecting lines exceed 400 feet in length, the cost of building the portion of any line in excess of that distance shall be paid by the subscriber or subscribers served thereby. If phones are furnished and maintained by applicant for subscribers obtaining this service, an additional charge of $8 per year, phone rental, shall be added to the rates above fixed, but no such additional charge shall be made in the event the subscriber shall furnish and maintain in good order a phone of standard type as prescribed by the by-laws or rules and regulations of applicant.

New York's Last Roof Fixture Taken Down.

New York, N. Y.—Gone is a soft snap for New York property owners. Gone is the mint for the wire thieves. The "Way-leave Agents" now are at the service of the diplomatic corps when there are vacancies for A-1, never-miss diplomats. New York's last roof fixture has been removed. With the passing of the last roof fixtures the telephone veterans are recalling some of the fancy work they had to do in keeping roofs in repair in accordance with the telephone company's contract. Blackwell's Island will miss some guests, too. At one time 42 telephone wire thieves were doing time over the river, in the happy days of the roof wire mazes.

Tecumseh Begins Construction—Pruyne New Manager.

Tecumseh, Mich.—An active construction campaign is being conducted by the Tecumseh Telephone Co. M. E. Pruyne, for nine years manager of the Blissfield (Mich.) Telephone Co., recently has been appointed manager at Tecumseh.

OIL PHONES BUSY.

Southwestern Spends $300,000 Because of Oil Industry's Demands.

Texas oil fields are served by two main toll lines converging at Fort Worth and thence into Dallas. One of the toll lines extends to Amarillo in the Panhandle through Wichita Falls in north Texas. This line will cost around $155,000. West Texas oil interests have been afforded dependable telephone service through the construction of a main toll line reaching out from Weatherford to Cisco and Eastland and Ranger. The distance from Weatherford to Cisco is 84 miles. This is one of the most important leads in the state, extending through the heart of the Texas oil fields, and with its tributaries is the principal outlet of the Dallas-Fort Worth toll centers. The Weatherford-Cisco line will entail an expenditure approximating $152,000.

Supervision of this oil field service now is in the hands of F. M. Hoag, of Dallas, who has been elected manager of the Bell system in Texas, and also manager of the Dallas Telephone Co. Mr. Hoag succeeds E. F. Carter, formerly of Dallas, who has been transferred to St. Louis as commercial manager of the Southwestern Bell Telephone Co. in Missouri, Kansas, Arkansas, Oklahoma and Texas.

A COON CROSS.

Trained Coon, A. W. O. L., Gets Tangled in Unique Trouble.

Hope, Ark—J. P. Whitson, wire chief for the Arkansas Natural Gas Co., has a new cause of wire trouble to add to the long list compiled during his sixteen years' service. A pet coon and its brass chain figure in the tale Whitson tells. He says:

"Recently the Mackay Co. had a swinging cross on their line between Little Rock and Benton, Ark., on the Rock Island Railway. They sent a lineman out of Little Rock on it.

"As he was watching his line closely from the train near Benton he saw something that looked like a cat on the top of a pole. This being the only thing unusual he saw anywhere he got a jitney at Benton and drove to the place where he saw the cat.

"When he got back there he found a pet coon with a brass chain around its neck. The coon had climbed up the pole and got its chain hung and wrapped around the wires. Every once in awhile it would pull on chain and this would draw its body against wires introducing it to about 500 volts which was distressing it considerably.

LAUDS INDEPENDENTS.

War Department Awards Certificate of Merit to U. S. I. T. A. for War Work.

Washington, D. C.—President F. B. MacKinnon of the U. S. Independent Telephone Assn., has sent to members of the organization a copy of the War Department's Certificate of Merit, awarded for services to the Signal Corps during the war.

Mr. MacKinnon, in transmitting copies of the award to the member companies, writes:

"We are sending you a copy of the Certificate of Merit awarded the United States Independent Telephone Association, by the War Department in appreciation of the services rendered the country during the war, by the Independent telephone companies in supplying men for the Signal Corps and maintaining the telephone service of the country. The Certificate of Merit is a testimonial of the government's appreciation of the part that you took in the war. This is fully set forth in the citation of the Chief Signal Officer, which we have printed below the copy of the certificate.

"The association and each of its member companies may well be proud of this certificate from the War Department and the citation by General Squier, who personally was in close touch with the activities and sacrifices of our companies and employes.

"I take the greatest pleasure in sending the certificate to you. I am sure you will agree with me that it should be framed and hung in your office, and that you will take much pride in displaying it."

HELL-O FITS HERE.

Hobart Welcomes Auditors to Land of Asbestos Insulated Lines.

Chicago, Ill.—Maybe it comes from auditing expense accounts, or it may be just a gift, but George Hobart, dean of the Bell's traveling auditors, has a happy imagination that handed C. S. Bigelow, traveling auditor of the A. T. & T. Co. at Chicago, a laugh he passed on to the Bell Telephone News man.

Here's the yarn:

"It was with a great deal of interest and some perplexity, therefore, that readers of the Chicago Daily Tribune noticed the following paragraph in 'A Line-o'-Type or Two':

YES, YES, GO ON!

(From the Pas, Man., Herald)

Mr. George Hobart, who died at the Nelson House last year, has arrived at his destination.

"C. S. Bigelow was among those mystified by the item and he immediately sent it to the office manager of the accounting department in New York, where Mr. Hobart was supposed to be located, and asked for his present address. Imagine Mr. Bigelow's surprise and satisfaction to receive the following reply from none other than Mr. Hobart himself:

"'What a hell of a question!

"'My present address is Brimstone Alley, corner of Sulphur Avenue, five minutes from the Foundry, where I work.

"'The climate is remarkably even—about 900 in the shade. We call it a very mild, open winter down here.

"'I feel it is a question of a very short time before all of us traveling auditors are happily united here, and the temperature may reasonably be expected to go up another hundred degrees or so.

"'The fumes made me cough a little at first, but one soon gets used to it.

"'The management at the Foundry is very kind and thoughtful. We are worked in shifts of 98 hours each, with eleven seconds off for lunch—ice water extra—9 years' pay deducted for every drink. Come soon—I think you will like it.'"

Java Adding to Telephone Equipment.

Semarang, Java.—Three more central offices are being installed in Semarang and suburbs. Java's telephone service now is purchased almost entirely in the United States. A long distance line runs from Batavia to Soebabaya, a distance of 500 miles. The country is in thriving condition and affords excellent opportunities for telephone development.

TELEPHONING CUBA.

Key West-Havana Cable Opened by Memorable Ceremony—26 Cities Talk.

Washington, D. C.—Cuba now has another great attraction. Its telephone cable, running almost a hundred miles under water between Key West and Havana, was opened April 11 by impressive ceremonies in which President Harding talked with President Menocal. The American end of the event was staged at the National Press Club in Washington. President Harding and a thousand others were given telephones cut into the U.S.-Cuban line.

A feature of the evening was a conversation between Catalina Island, Cal., and Havana. The Catalina talk was wirelessed to Los Angeles, carried by transcontinental lines to Key West, thence by the submarine cable to Havana.

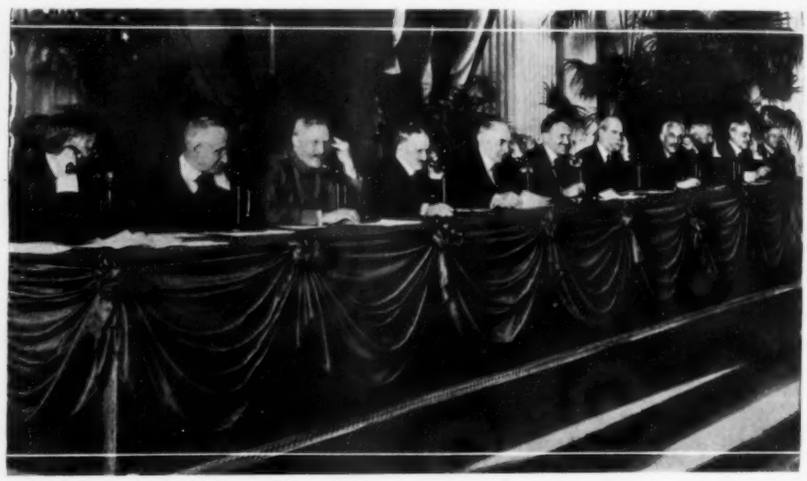


Photo by Underwood & Underwood

The Notables Listen In as President Harding Opens U. S.-Cuba Telephone Service. Left to right: Colonel Carty; R. J. M. Wainwright, Assistant Secretary of War; General John J. Pershing; Dr. Carlos M. de Cespedes, Cuban Minister to the U. S.; President Harding; Dr. L. S. Rowe, Director of Pan American Union; Charles Evans Hughes, Secretary of State; Andrew W. Mellon, Secretary of Treasury; Henry P. Fletcher, Undersecretary of State; Cuno Rudolph, District Commissioner, and Avery Marks, President National Press Club.

Roll call of twenty-six cities taking part in the conversation was conducted by Col. J. J. Carty, vice president of the A. T. & T. Co.

Havana also saw a gala event at the opening. President Menocal was host to a notable gathering.

The U.S.-Cuba cable-laying was another triumph for American telephone engineers. Water between the two landing places is 6,000 feet deep in spots, necessitating a specially constructed cable to care for the heavy compression. The cables are grounded at sea. Three separate cables, laid five miles apart, form the lines of telephonic communication between the two countries. Temperature of water, speed of current and the cable-hungry toredo, gave the engineers on the job many a worry

Wave Filtration Principles

Elimination of Undesirable Frequencies in Long Distance Telephone Transmission With Electric Wave Filters—Their Design and Installation

By W. N. Furthman

In long distance transmission it is the present practice to use audion repeaters as electric wave amplifiers. These amplifiers are used in connection with loading coils in the Boston-San Francisco circuit. Soon after the loading coils were installed in this circuit it was found that many improvements had to be made in line conditions, which heretofore had been considered satisfactory. The changes applied particularly to improved methods of insulation and the designing of cables of low unbalanced capacity, and so it was also found when repeaters were added to this circuit, that it was further necessary to add additional appliances which would permit the installation of such a delicate piece of apparatus as an audion amplifier and still maintain the necessary commercial conditions under which it could be operated.

Wave Filtration Vital.

It was found that one of the principal objections to the use of a repeater was caused by its tendency to absorb and endeavor to repeat all of the electrical waves that passed through a composited telephone and telegraph circuit. In other words it had a tendency to repeat alternating currents of all frequencies which passed through it. This natural, but unsatisfactory condition of the circuit was overcome by the use of electric wave filters. This wave filter was so designed that all frequencies lying outside a pre-assigned range or ranges of frequency would not be transmitted, and those that were transmitted, by a pre-assigned arrangement, would be transmitted without appreciable decrease in current. In general this wave filter is constructed in the form of an impedence element or elements in series with the line, and the impedence element or elements in shunt across the line, the values of these impedence elements being so proportioned that the structure will transmit with negligible attenuation frequencies it is desired to translate, while extinguishing currents of all frequencies lying outside of pre-assigned limits.

Wave Filter Construction.

Referring to Figs. 1 to 7, inclusive, each wave filter, 1a, 1b, 1c, 1d, 1e, 1f and 1g, is composed of a plurality of identical sections, 2a, 2b, 2c, 2d, 2e, 2f and 2g, respectively, each including impedences in series with the line and impedences in shunt across the line. These impedences are provided with condensers, C1 and C2, or by inductance coils, L1 and L2, or by a suitable arrangement of both, there being at least, for each section of the wave filter, an inductance element in series with the line and a capacity element in shunt across the line, or vice versa. In Figs. 2 to 7, inclusive, impedence elements for each section are included as follows: In Fig. 2 there is a condenser in series with the line and an inductance coil in parallel in shunt across the line. In Fig. 3 a condenser and an induction coil in series with the line and an inductance coil in shunt across the line; in Fig. 4 an inductance coil in series with the line and a condenser and an inductance coil in parallel in shunt across the line; in Fig. 5 a condenser and an inductance coil in series with the line and a condenser across the line; in Fig. 6 a condenser in series with the line and an inductance coil in shunt across the line; in Fig. 7 an inductance coil in series with the line and a condenser in shunt across the line.

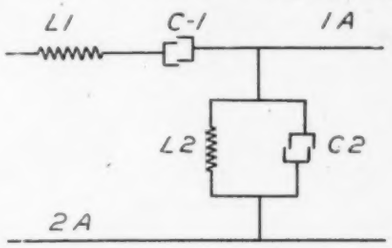


FIG. 1

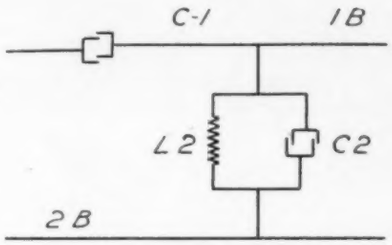


FIG. 2

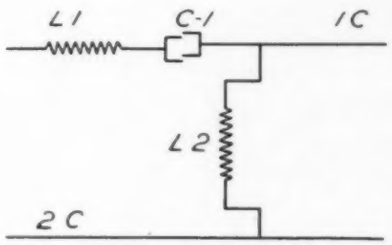


FIG. 3

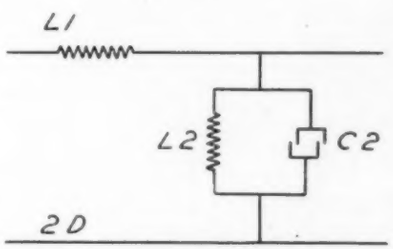


FIG 4

Elimination of Frequencies.

By assigning suitable values to condensers and inductance coils, it will be clear that any pre-assigned ranges of frequencies may be successfully eliminated. It is a well known fact that in a uniform transmission line, containing uniformly distributed resistance, inductance and capacity, attenuation of current along such a line is caused by resistance dissipation and becomes zero when the resistance becomes zero. In a structure, however, containing series impedence and shunt impedence a high attenuation may exist even when the resistance is practically zero. This attenuation is due not to resistance dissipation, but to involved reaction among the impedence units of the structure. These reactions and interactions taking place in the structure and determining the character and attenuation of transmission of periodic currents are so involved that it is necessary to resort to mathematical formulæ in explaining the electro magnetic loss taking place in the structure. For this purpose assume a structure consisting of a series of sections, each section having an impedence Z_1 in series with the line and an imperence Z_2 in shunt across the line. Let Jn denote the current flowing in the nth section of the structure, J (n-1) the current flowing in the (n-1)st section, J (n+1) the current flowing in the (n+1)st section, and applying Kirchoff's law to said currents and circuits, it follows that:

$$Z_1 Jn + Z_2(Jn - Jn+1) + Z_2(Jn - Jn-1) = 0$$

By various re-arrangements this equation may be re-written as follows:

$$\frac{Jn+1}{Jn} + \frac{Jn-1}{Jn} = \frac{Z_1}{Z_2} + 2$$

For the structure shown in Fig. 1, it is evident that the series impedence

$$Z_1 = \frac{1 - L_1 C_1 p^2}{i\, p\, C_1}$$

and the shunt impedence

$$Z_2 = \frac{i\, L_2\, p}{1 - L_2 C_2 p^2}$$

In these formulæ p equals $2\pi f$ where f is the frequency in cycles per second and i is the imaginary quantity

$$\sqrt{-1}$$

2. Referring to the expressions for Z_1 and Z_2, it is evident that the variable or unknown quantity has a value of p. There are four roots or four values of p which will satisfy equation No. 4.

$$\frac{Z_1}{Z_2} = 0$$

$$Z_1 = -4Z_2$$

These values of p having symbols p_0, p_1, p_2 and p_3 have the following root values:

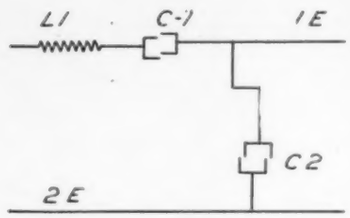


FIG. 5

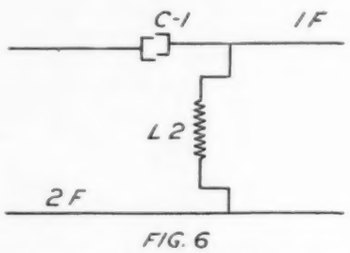


FIG. 6

and p_3. In Fig. 8 the ordinates are received currents while the abscissæ are frequencies. Fig. 9 has as its ordinates attenuation values per section and as abscissæ frequencies. The full line curves refer to the ideal structure in which the resistance of the impedence units is negligible, while the broken line curves show the departure from the ideal structure due to the resistance of the structure. Referring to Fig. 8 and to the equation showing the value of p, it

$$p_3 = \frac{1}{\sqrt{2L_1C_2}}\sqrt{4 + \frac{L_1}{L_2} + \frac{C_2}{C_1} + \sqrt{\left(4 + \frac{L_1}{L_2} + \frac{C_2}{C_1}\right)^2 - 4\frac{L_1C_2}{L_2C_1}}}$$

$$p_0 = \frac{1}{\sqrt{2L_1C_2}}\sqrt{4 + \frac{L_1}{L_2} + \frac{C_2}{C_1} - \sqrt{\left(4 + \frac{L_1}{L_2} + \frac{C_2}{C_1}\right)^2 - 4\frac{L_1C_2}{L_2C_1}}}$$

$$p_1 = \frac{1}{\sqrt{L_1C_1}} \quad = \quad p_2 = \frac{1}{\sqrt{L_2C_2}}$$

It will be seen that these four limiting values of p or $2\pi f$ are in proportion, and that:

$$\frac{p_3}{p_1} = \frac{p_2}{p_0}$$

An examination of these equations shows that the unattenuated frequence lies in two distinct continuous ranges, if $p_1 > p_2$, the frequencies of unattenuated transmission, lie between $p_3/2\pi$ and $p_1/2\pi$ for the upper band and $p_2/2\pi$ and $p_0/2\pi$ for the lower band. If, on the contrary, $p_1 < p_2$, the frequencies for the upper band, lie between $p_3/2\pi$ and $p_2/2\pi$, and for the lower band between $p_1/2\pi$ and $p_0/2\pi$.

Transmission Through Filters.

Referring to drawings 8 and 9 show the character of transmission through the structure illustrated in Fig. 1. In Figs. 8 and 9, f_0, f_1, f_2 and f_3 represent frequencies corresponding to p_0, p_1, p_2 will be clear that if the two bands of free transmission are made to merge into one by setting $f_1 = f_2$ there remains

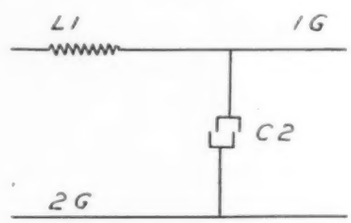


FIG. 7

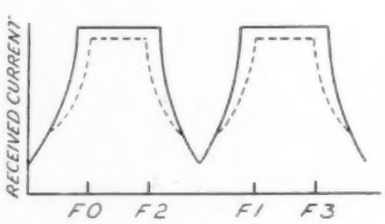


FIG. 8

one single band of free transmission. The first form of single band wave filter is attained by making $f_1 = f_3$ or $L_1C_1 = L_2C_2$. The second method of realizing a single band wave filter is attained by relegating the upper band to infinity or the lower band to zero. Equations on the value of p show that one band is removed to infinity if L_1 or C_2 equal zero, while either band is removed to zero if L_2 or C_1 equal oO. It will be seen that an infinite inductance or zero capacity are equivalent to an infinite impedence, and it is therefore logical that a circuit through the same may be regarded as replaced by an open circuit, and since, on the other hand a zero inductance or an infinite capacity are equivalent to a zero impedence they may be regarded as in effect short-circuited. It will also be seen therefore that there are seven ways of reducing the double band wave filter to a single band wave filter, as follows:

(a) Making the two broad bands confluent by setting $L_1C_1 = L_2C_2$;

(b) Relegating one band to infinity by making $L_1 = 0$;

(c) Relegating the other band to infinity by making $C_2 = 0$;

(d) Relegating one band to zero by making $C_1 = \infty$;

(e) Relegating the other band to zero by making $L_2 = \infty$;

f) Making $L_1 = C_1 = \infty$ and thereby transmitting freely all frequencies above a specified value;

(g) Making $L_2 = C_1 = \infty$ and thereby transmitting all frequencies below a specified value.

Provided it is desired to design a filter which shall freely transmit all frequencies lying between the limiting frequencies f_3 and 1_1, also between f_2 and f_0 with the provision that $f_3 > f_1 > f_2 > f_0$ and

$$\frac{f_3}{f_1} = \frac{f_2}{f_0}$$

The formulæ determining the relations obtaining among the electrical constants are deducible from the values shown above for p_3, p_0, p_1 and p_2 are as follows:

$$L_1C_1 = \left(\frac{1}{2\pi f_1}\right)^2$$

$$L_2C_2 = \left(\frac{1}{2\pi f_2}\right)^2$$

$$\frac{L_2}{L_1} = \frac{1}{4}\left(\frac{f_1}{f_0}\right)^2\left[1 - \left(\frac{f_0}{f_1}\right)^2\right]\left[1 - \left(\frac{f_0}{f_1}\right)^2\right]$$

$$\frac{L_2}{L_1} = \frac{1}{4}\left(\frac{f_1}{f_2}\right)^2\left[1 - \left(\frac{f_3}{f_1}\right)^2\right]\left[1 - \left(\frac{f_3}{f_2}\right)^2\right]$$

Wave Filter Design.

The rules of design of the single band wave filter are as follows:

(a) Confluent bands in which case $L_1C_1 = L_2C_2$. This form is shown in

Fig. 1, and the rule of this formula is obtained by causing the two bands of frequencies to coalesce. Provided the frequencies to be freely transmitted are to lie between the upper limiting frequency f_3 and the lower limiting frequency f_0 the design formulæ are as follows:

$$L_1C_1=L_2C_2=\left(\frac{1}{2\pi f_3}\right)\left(\frac{1}{2\pi f_0}\right)$$

$$\frac{L_2}{L_1}=\frac{1}{4}\left(\frac{f_0}{f_3}\right)\left(\frac{f_3}{f_1}-1\right)^2$$

(b) Relegating one band to infnity by making $I_1=0$, in which case the limiting frequency of the upper limit is f_2 and f_0 the lower limit. The design equations for this form are:

$$L_2C_2=\left(\frac{1}{2\pi f_2}\right)^2$$

$$\frac{C_1}{C_2}=\frac{1}{4}\left[\left(\frac{f_2}{f_0}\right)^2-1\right]$$

This form is shown in Fig 2.

(c) Relegating one band to infinity by making $C_3=0$, in which case the structure for the wave-filter is as shown in Fig. 3. The formulae for the limiting frequencies being f_1 for the upper limit and f_0 for the lower limit are as follows:

$$L_1C_1=\left(\frac{1}{2\pi f_1}\right)^2$$

$$\frac{L_2}{L_1}=\frac{1}{4}\left[\left(\frac{f_1}{f_0}\right)^2-1\right]$$

(d) Relegating one band to zero by making $C_1=\infty$ as shown in Fig. 4. The limiting frequencies being f_3 and f_2 the design formulæ are as follows:

$$L_2C_2=\left(\frac{1}{2\pi f_2}\right)-1\Big]$$

$$\frac{L_2}{L_1}=\frac{1}{4}\left[\left(\frac{f_3}{f_2}\right)^2-1\right]$$

(e) Relegating one band to zero by making $L_3=\infty$ as shown in Fig. 5. Limiting frequencies being f_2 and f_1, design formulæ are as follows:

$$L_1C_1=\left(\frac{1}{2\pi f_1}\right)^2$$

$$\frac{C_1}{C_2}=\frac{1}{4}\left[\left(\frac{f_3}{f_1}\right)^2-1\right]$$

(f) Making $L_1=C_2=0$, in which case the wave filter assumes the form shown in Fig. 6 and transmits all frequencies above a definite inferior limit. If the inferior limit is specified as f_1 the formulæ is

$$L_2C_1=\frac{1}{4}\left(\frac{1}{2\pi f_0}\right)^2$$

(g) Making $L_2=C_1=\infty$ as shown in Fig. 7, in which case the wave filter freely transmits all frequencies below a specified superior limit. If the superior limiting frequency is specified as f_3 the design formula is as follows:

$$L_1C_2=4\left(\frac{1}{2\pi f_3}\right)^2$$

In all of these formulæ it will be noted that there is always one impedence element whose value is a matter of choice. The value of this element may be determined from convenience of design or may be made to satisfy some other specified requirement, such as, for instance, that the line should have a definite impedence at a particular frequency.

It is to be understood that the number of sections of the wave filter will depend on the degree to which it is proposed to extinguish the currents to be filtered out. If the number of sections, therefore, is doubled, the ratio of the current of any frequency entering the filter to the current of the frequency leaving the filter is approximately squared.

Typical Filter Design.

Assume that it is proposed to design a filter which shall transmit all frequencies lying between 200 and 2,000 cycles per second. Any one of the forms shown in Figs. 1, 2, 3, 4 and 5 may be employed, or the two forms shown in Figs. 6 and 7 connected in series. Let it be assumed that convenience or other considerations lead to the selection of the type of wave filter shown in Fig. 1. Applying the design formulæ shown under (a) applicable to this type of single band wave filter and substituting in that formula for f_0 and f_3 the assigned values for frequency of 200 or 2,000 respectively the formula will read as follows:

$$L_1C_1=L_2C_2=\left(\frac{1}{2\pi 2000}\right)$$

$$\left(\frac{1}{2\pi 200}\right)=(.635)10^{-7}$$

$$\frac{L_2}{L_1}=\frac{1}{4}\left(\frac{200}{2000}\right)\left(\frac{2000}{200}-1\right)^2=2.025$$

Therefore the above stated requirements are satisfied if

$$L_1C_1=L_2C_2=(.635)10^{-7}$$

and

$$\text{and } \frac{L_2}{L_1}=2.025$$

Since one of the constands $L_1C_1L_2C_2$ is arbitrary and that convenience or other considerations dictate a value of 1 henry for L_2 the values of the several impedence elements are then as follows:

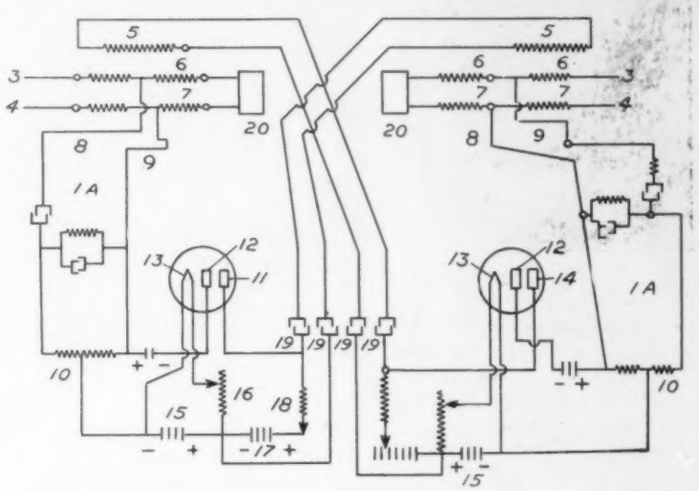


FIG. 10

$L_2=1$ henry;; $L_1=.494$ henry; $C_1=(5.14)10^{-7}=0.514$ microfarads and $C_2=.254$ microfarads;

Therefore the wave filter shown in Fig. 1 having its impedance elements of the values above derived will transmit freely currents of all frequencies lying between 200 and 2,000 cycles per second. The attenuation constant per section at a frequency of 2,200 cycles per second, for example, is found by computation to be .98 and the ratio of currents in adjacent sections is 2.67 approximately, and if five sections are employed the current at this frequency is less than 2 percent of its value in the first section, while currents of frequency lying between 200 and 2,000 cycles per section are practically without attenuation.

Aftermath of Boycott Confronts Bloomfield, Neb.

Bloomfield, Neb.—The State Journal says citizens of Bloomfield who cut out telephone service recently rather than accede to what they termed unreasonable telephone rates, have been informed by the attorney general their action was liable to prove costly, due to their action in concert.

AUTOMATIC PROMOTIONS.

Benoist as Asst. General Mgr.; Blomeyer as Sales Mgr.— Other Advances Made.

Chicago, Ill.—Two men prominent in the telephone industry have been advanced by the Automatic Electric Co. as one of the important steps in expansion of the executive organization made necessary by the increasing range and size of that company's operations.

W. F. Benoist.

These promotions of W. F. Benoist from head of the sales department, which position he has occupied since July 1, 1919, to assistant general manager, and of E. C. Blomeyer to sales manager will allow H. A. Harris, vice-president and general manager of the Automatic, increased opportunity to devote his time and efforts to supervisory work and the formulation and execution of Automatic policies.

To the new and important duties which have been assigned him, Mr. Benoist brings a unique equipment of training and experience. In 1900 he entered the telephone field as Assistant Secretary of the Kinlock Long Distance Telephone Co., with headquarters in St. Louis. Familiarity with the operating end of the business thus gained was supplemented by a number of years as an associate of Charles H. Ledlie, consulting utility expert, of St. Louis. During this time Mr. Benoist gave his attention to the construction, operation and appraisal of numerous large operating units throughout the middle west and southwest territory, becoming thoroughly in touch with the utility side of telephony.

In 1909 Mr. Benoist entered the Automatic Electric Co. organization as assistant to the sales manager, and for the past thirteen years he has devoted his efforts not only to sales work, but also to the general problem of production and organization management. Since July, 1919, Mr. Benoist has been in direct charge of the sales work of the company, a position which has brought him into close touch with all parts of Automatic Electric Company's activities, and enables him to view the organization both with the perspective of operating and constructive experience, and also with the close insight which comes from long personal contact.

In appointing Mr. E. C. Blomeyer sales manager, with full direction and supervision over the company's relations with customers, present and prospective, the management feels that a man of exceptional qualifications has been placed at the service of the purchasers of its equipment.

Beginning as a collector for a small independent telephone company in Missouri in 1904, Mr. Blomeyer progressed steadily in the telephone field, filling various executive positions until in 1918 he become president of the Texas Telephone Co. In this way he not only obtained a thorough knowledge of the details of the telephone business, but also secured a broad and comprehensive view of the general problems of policy, public relations and management.

Mr. Blomeyer still further broadened his activities by keeping in close touch with association work, both state and national, being president of the Texas Independent Telephone Association for a year and a half, and took a prominent part in the affairs of the United States Independent Telephone Association.

Mr. Blomeyer is known nationally to telephone men as the author of his series of "Letters to Managers," and has acted as spokesman for the operating companies through the advertising and news copy he has prepared for the United States Independent Telephone Assn., and his "rate chart" and accompanying lecture used extensively by the telephone companies in rate cases during recent years.

Added to his experience as an organizer, executive operating official, publicist and author, Mr. Blomeyer has devoted his attention intensively to the sales problems of Automatic Electric Co. since he entered the organization in August, 1920. Since January 1, he has been contract sales manager for both Automatic Electric Co. and the International Telephone Sales and Engineering Corp., and as such has had supervision over foreign business and contract sales relations. Mr. Blomeyer retains his supervision over the sales activities of the International Telephone Sales and Engineering Corp.

Mr. J. H. Finley, for the past eight years connected with the sales department, has been assigned the handling of certain special duties, and will continue to supervise office and service activities. Mr. R. H. Burfeind, since 1914 a member of the sales staff, has been appointed assistant sales manager, and will give attention to general sales. Mr. W. N. Curtis, formerly special representative of the company in New Zealand, and later engaged in sales work in the United States, has been appointed assistant sales manager and will give special attention to contract sales matters.

E. C. Blomeyer.

KELLOGG'S 24TH YEAR.

April Marks 24th Birthday of Kellogg Switchboard & Supply Co.

Chicago, Ill.—On April 28 the Kellogg Switchboard & Supply Co. reached its 24th birthday. Referring to this event the company remarks:

"The advent of the company in the telephone field came under the most favorable conditions, and now on our 24th birthday we are still growing. Almost a quarter of a century we have traveled our business highways, beset with the usual perplexities and obstacles.

"We note from the minutes of the board of directors meeting a resolution authorizing the signing of the contract with the St. Louis Electric Construction Co. for the building of the first Kellogg installation—the Kinloch Telephone Co., of St. Louis. This contract was signed April 27, 1897, and really constituted the 'start' of the Kellogg Switchboard & Supply Co."

Windom, Minn., Exchange in a New $60,000 Home.

Windom, Minn.—With a ceremony attended by leading business men the Tri-State Telephone Co. opened its new exchange here. The new plant cost more than $60,000, of which $20,000 is represented by the exchange building and $26,500 by the switchboard and inside equipment. Almost $10,000 will be spent on the work remaining in the plant's rebuilding campaign.

Railroad Telephone Practice

New York Central Telephone Engineer Continues Notable Series — Figures on Energy Consumption of Selector Circuits

By Stanley Rhoads
(From Paper Read Before A. I. E. E.)

Welded Iron Wire Joints.

Another step in the improvement of iron wire for telephone circuits is due to oxyacetylene welding of the joints. This has been successfully done on the No. 8 B.W.G. iron wires of the Hocking Valley, Zanesville & Western, and the Cleveland, Cincinnati, Chicago & St. Louis railroads. The resistance of a welded joint is 95 percent of that of an unspliced wire, whereas the usual soldered joint is 112 percent of the unspliced wire. Many apparently soldered joints are really not soldered and are about 200 times the resistance of the same length of unspliced wire. The joints are painted with red lead after welding. The work is not excessive in cost and the result is a considerable reduction in resistance and is of a permanent nature. A recent job of welding on the C. C. C. & St. L. railway cut the transmission equivalent of the circuit almost in half.

Composite Ringer.

The operation of a type B composite ringer was investigated with the oscillograph, with the results shown in Fig. 14. Oscillogram No. 193 is the simultaneous record of the outgoing signals when the home station operator rings. Trace No. 1 is the 16-cycle motor-generator ringing current from the operator's keys. Trace No. 3 is the 133-cycle current as produced by the interrupter and delivered to the line, and is flowing to a station 150 miles away over a No. 9 A.W.G. copper phantom circuit, composited.

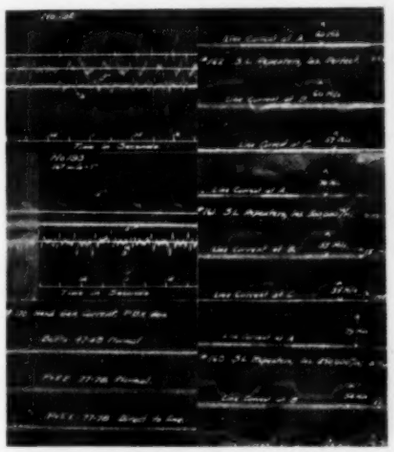


Figure 14.

Oscillogram No. 192 is the record of an incoming signal from the distant office. Trace No. 2 is the wave at a point in series with the high frequency relay and is the deflection calibrated at 50 milliamperes per inch, whereas the No. 1 and No. 3 are 167 milliamperes per inch as in No. 193. The waves do not resemble sine waves to any noticeable extent, but are distorted more like transformer magnetizing current. Oscillogram No. 170 is shown for comparison with hand generator ringing current and presents three separate exposures; the top one on a No. 8 B.W.G. iron wire way-station message selector telephone line, Indianapolis to Bellefontaine; and the middle one is the same generator ringing on a similar circuit, Indianapolis to Springfield, O., through a No. 47-A repeating coil; and the lower trace is on the same line without the repeating coil. The calibration of the oscillograph vibrator elements was not alike in tnese three exposures.

Energy Consumption.

Several tests have been made to determine the energy consumption of different circuits used in railroad service, particularly those which use primary battery, in order to compare costs of different types of battery. In general, the ampere-hour energy consumption was recorded by copper voltmeters and in some cases by watt-hour meters, for periods of 24 hours, of days that were considered average. The number of calls on selector telephone circuits was regis-

TABLE III

Energy Consumption Data on Various Selector Telephone Circuits.

C. C. C. & St. L. Ry.

Division Name	Circuit No.	Length of Line, Miles	Kind of Wire C-Copper I-Iron	Size of Wire No. 9 AWG No. 8 BWG	Type of Selectors 4G5 = 5000, 4G16 = 1600, 4G7 = 7000	No. of Selectors	Voltage at Generator	Milliamperes at Generator	During 24 hours							
									A. C. Motor kw. Hours	No. of Calls	No. of Trains	Ampere hours				
												Call Box Battery	Main Line Battery	Selector Main Line Battery	Selector Local Battery	Main Line Volt Ampere Hours
Cincinnati	31–2	78.7	C	9	4 G 5	32	160	200	3.6	1223	85	0.716	0.245		0.154	39.2
Columbus	"	45.1	"	9	4 D 16	20	"	145		"	43				0.152	
Delaware	"	49.9	"	9	4 G 7	12	"	72		"	19				0.206	
Above three are operated as one circuit																
Cincinnati	73–4	78.7	I	8	" 5	43	330	218	5.1	403		0.275	0.496		0.145	163.5
Columbus	71–2	45.1	"	8	" 5	21	85	82		173		0.079	0 0199		0.27	16.9
Delaware	71–2	49.9	"	8	" 7	13	78	64		319		0.304	0.38	0.27	0.11	29.7
Sandusky	31–2	130.7	C	9	" 7	33	107	105	3.5	539	83		0.3	0.07	0.208	32.1
Sandusky	75–6	34.0	I	8	" 5	13	170	138	3.7	163		0.379			0.55	
Chicago East	31–2	109.6	C	9	" 16	32	210	250			45	0.095	0.085			17.8
Chicago West	31–2	139.8	"	9	102-C	35	180	260			35	0.162	0.094			16.9
Peoria & Eastern	31–2	211.5	"	9	102-F	55	300	285	13.3		22	0.076	0.130			39.0
Springfield	31–2	140.1	"	9	102-C	34	140	150			15	0.13	0.086			12.0
Chicago East	51–2	109.6	"	9	4 G 16	34	240	250				0.101	0.045			10.8

TABLE IV.

Energy Consumption Data of Transmitters, for 24 Hours. Gen. Telg. Office, Indianapolis, C. C. C. & St. L. Ry.

Transmitter tested	Battery supply	Ampere hours
Chi. Div. Dist.:		
East	8 B. S.C.O. cells	1.162
West	8 B. S.C.O. cells	1.499
Chief Disp.	4 B. S.C.O. cells	0.069
Msg. Opr.	4 B. S.C.O. cells	0.1365
Car Dist.	4 B. S.C.O. cells	0.0199
P. & E. Disp.:		
East	8 B. S.C.O. cells	1.765
West	8 B. S.C.O. cells	0.845
Supt.-Car Dist.	8 B. S.C.O. cells	0.0659
Supt. Terminals	5 dry cells	0.0265
Wire Chief	10 dry cells	0.0522
Short line	3 dry cells	0.00269
Total		5.55

tered automatically on Veeder counters. The records for several telephone dispatching circuits are given in Table III.

The number of calls per day is interesting. It runs as high as 1,223, which is as high as on any existing dispatching circuit, because it is an exceptionally busy line and one man could not do much more on one circuit.

The record of transmitter energy consumption is given in Table IV for several offices in the C. C. C. & St. L. general office building, Indianapolis. The above record gives data for the total of all transmitters in the general office building, and a four-volt, 25-ampere-hour battery was set up, which has since supplied all these transmitters.

The shunt field current of a motor of a dispatcher's selector-circuit motor-generator was found to be 0.3 ampere, which is eight ampere-hours per day, sufficient to charge the 24-ampere-hour battery on the transmitters. The storage battery was placed on continuous charge in this shunt field circuit without either affecting the other detrimentally.

It was noted in making the transmitter current tests that new transmitters of a given type use more current than old ones, in some cases twice as much. This is in conflict with the general belief that old transmitters are "packed" and consequently use more current. An explanation for the higher resistance of old transmitters is that the granules lose their many sharp edges and become more nearly round with fewer points of contact with other granules, which increases the resistance of the carbon as a whole, with resultant smaller current flow.

Table V shows the record for a selector calling-key battery which was provided for by a twelve-volt, six-ampere-hour storage battery connected in the shunt field of a small motor of a dispatching-circuit motor-generator set.

A test was made on a 48-volt storage battery supplying a Western Electric Co. No. 10, private branch exchange with 45 stations at Beech Grove shops. The board is operated from 8 a.m. to

TABLE V.

Energy Consumption Data of Call Boxes for 24 Hours. Gen. Telg. Office, Indianapolis, C. C. C. & St. L. Ry.

Chi. Div. Disp. East	6 dry cells	0.0957
Chi. Div. Disp. West	8 dry cells	0.1625
Chi. Div. Msg. Opr.	8 dry cells	0.101
P. & E. Dis. East	8 dry cells	0.1326
P. & E. Dis. West	8 dry cells	0.0761
Total		0.567

5 p.m., except Sunday, and has six trunks to the main railroad exchange at Indianapolis. The record showed 5.27 ampere-hours per day. The charging rate was based on this at five amperes for eight hours, once per week, with suitable overcharge periods.

A four-ohm sounder used 1.25 ampere-hours in a 24-hour period on two gravity cells. The record for the Chicago division message operator shows (Table IV) 0.1365 ampere-hour in 24 hours. This transmitter is in almost constant use, sending and receiving messages for the division superintendent's office. Therefore it can be said to fairly represent the average busy local battery telephone on a railroad, consuming more energy than the average way station or

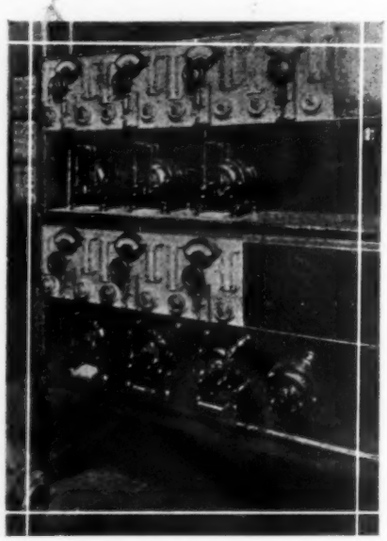


Figure 15—Unit Type Power Switchboards for Selector Telephone Circuits.

block tower. On this record it could be predicted that a 300-ampere-hour set of batteries of equivalent voltage would last 2,200 days, or six years. Actually, they would not last quite so long, but are known to last three years and more in this service. At an initial cost for four cells of $8.94 and renewal cost of $5.72 for consumable elements, the cost is less than $2 per year, based on three-year life of renewals. Dry cells, three per set, would last about three months and cost about $4.50 per year at 28 cents each. In addition to saving in cost, the caustic soda cells give desirable reliability and require less labor expense. It is standard practice to connect the transmitters of all telephones at any station and all the telephone selector bells to the same set of caustic soda battery.

Unit Type Power Switchboards.

The rapid and uncertain growth of dispatching and message telephonic circuits has made it difficult to plan motor-generator sets for battery supply and keep a neat layout of power plant. The C. C. C. & St. L. railway experienced this trouble and the unit type was adopted. This is shown in Fig. 15. Morse battery supply also has been installed on this plan at Springfield, O., to fit in with the units for the selector lines.

The plan provides one square foot of power panel with the motor and generator line switches, line fuses for both generator and motor, field rheostat, circuit breaker and voltmeter for each machine and in close relation to it. The generator circuits are taken through a jack panel at the left end of the bench, where any machine can be put on any circuit. This type of power installation saves space and puts the control apparatus in close proximity to the motor-generator.

Dry cells have been supplanted by motor-generators and sodium-phosphate-aluminum-iron chemical rectifiers for selector telephone circuits, to a great extent. The motor-generators in the first installations had shunt-wound generators with the inherent characteristic of drop-off in voltage with increase of load, which was undesirable on selector telephone lines. The load on a dispatcher's circuit consists of series of twenty or thirty short impulses, seldom more than 1,500 series per day, which is practically no-load from a power standpoint. The efficiency of a machine, therefore, is of less importance than good voltage regulation. The compound generator has been used in all recent installations on the New York Central Lines, separately excited if the motor power supply is direct current.

Alternating current has been found better suited for the motor supply than direct current, because of its better regulation. The direct-current power from railroad shops has poor regulation, due to the arc welders, etc., in the shops.

Quick starting motors have been used in some installations and, while fairly successful, are not preferred to the constantly running sets, because of excessive wear of the commutator, due to heavy starting current. Four-bearing motor generators have been found to give better results than the two-bearing type. Ring oilers are better than wicks.

Chemical Rectifier.

The use of the sodium-phosphate chemical rectifier is being extended. The

water, in which is suspended a semi-circular strip of iron separate about one inch from an aluminum strip. Fig. first few sets were purchased, but later installations are made up completely by the railroad installers. Four old type sal-ammoniac battery jars are used, containing a solution of commercial sodium phosphate, made up of one pound dissolved equally between the four jars of

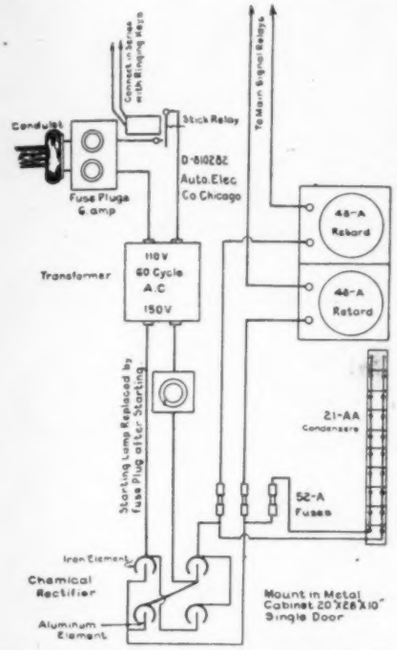


Figure 16—Wiring of Chemical Rectifier for Selector Telephone Circuits.

16 shows the wiring of such an outfit for a dispatching unit. The condensers and retard coils eliminate the hum of the alternating-current source on the telephone line. The stick relay normally disconnects the rectifier from the a-c. supply between calls on the dispatching line. Fig. 17 shows characteristic curves of such a set. The unmarked curve is the efficiency.

Line Insulation.

Low insulation apparently is due more to broken and chipped glass insulators than to smoked ones. A perfect insulator measured 40 megohms with a 500-volt megger meter, and a similar one measured 10 to 15 megohms with a piece of the outer petticoat of about two inches width knocked off, with the same condition of rain in both tests. An insulator so badly shattered that the tie-wire was holding it together, measured 1 megohm in a drenching rain and when thoroughly water-logged. A mechanically perfect insulator, but one very badly crusted by smoke, measured about 40 megohms, after a hard rain, which is about the same value a clean insulator shows. The crust deposited by smoke seems to have high resistance. The megger tests were made on actual lines from line wire to ground after cutting off the line wire about a foot each side of the tie-wire. It was found that the resistance from line to pin nearly always equaled the value from line to ground, when the pole and cross-arm were wet. It is important to keep chipped and broken insulators off a line on which the working margin demands good insulation. This is especially important on simplexes, because of the reduced insulation of the two wires in parallel.

Leakage from Wire to Wire.

Few references are available relating to the effect of line leakage of one wire on a pole line to a paralleling wire on an adjacent pin. This point came up in a study of a proposal to string a common return wire on an intercalling selector telephone circuit to take the place of a ground return installed on the Indianapolis Belt railroad, semi-circling the city. The telephone selector ground return was affected badly by the city street railway return current, also leakage in wet weather made the ground return so unreliable that some other plan was necessary. The third wire was proposed, but it was known that the insulation of the two wires to ground was very low in wet weather and it was feared that the leakage to the third wire would make the system inoperative at such times.

The experiences of telegraph and telephone men were obtained and the general opinion was that the leakage from the two line wires as a simplex to the third wire as a common return would be negligible. The effect was actually found to be less than one-third of the leakage current that existed with the ground return. Assuming that the wires of the telephone pair in wet weather had an insulation resistance of one megohm per mile each, which in parallel was one-half megohm to ground, the third wire with one megohm has its insulation resistance in series with the one-half megohm of the pair, which would make the result, theoretically, one and one-half megohms, or three times what it was between the pair and ground.

This type of intercalling system is limited to very short lines of perhaps a maximum of ten miles, due to the variable operating current of the simplex connection resulting from insulation leakage. The permissible length is 100 percent greater with a return wire than with a ground return. Circuits 100 to 150 miles have not proved successful.

The leakage from one wire of the pair to the other, under ordinary conditions on selector telephones lines, has

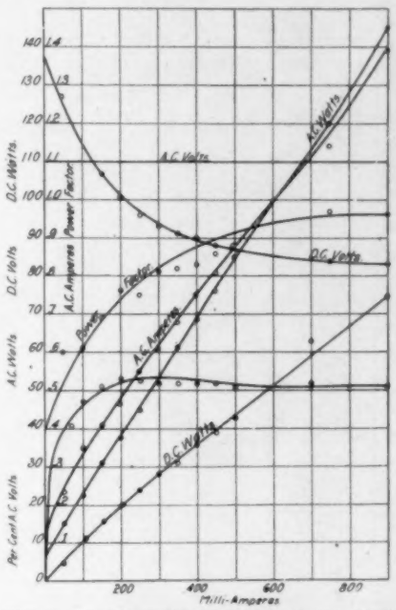


Figure 17—Character Curves of Chemical Rectifier.

on most types of selectors, and the total leakage current causes very slight additional voltage drop on the circuits and no noticeable effect upon selector operation. The net resistance is the sum of the resistance of each, and the effective voltage to cause leakage current falls from the value of the main battery, usually 200 to 300 volts at one end, to less than 50 volts at the distant end, no apparent effect on the selector operation.

The leakage from one telegraph wire to another can be detected by means of a voltmeter by opening one wire at the distant end, inserting the voltmeter at the home end between the line and ground, and applying voltage to the paralleling wire. The value of the leakage is so slight that it is seldom observed in the Morse relays of the circuits, if worked as single Morse, or on the polar relays if worked as a duplex. The electrostatic induction from paralleling wires, apparently, is noticed more than the leakage.

It has been stated that in the past the insulation of railroad circuits was too variable and low to permit of successful loading of open wire lines. Judging from recent tests of insulation, it is now believed to be feasible to load the railroad long-distance lines, which are limited to through service. It would probably not be successful on phantoms made up of selector telephone lines.

Telephone Selector Current and Voltage Waves.

In Fig. 20 retard coils and condenser naling circuit, which are for the purpose of modifying the voltage wave that is impressed on the line so that it

are indicated in a telephone selector sig- will not give listeners on the telephone a disagreeable sound shock. Some investigations were made on an artificial line of Fig. 22 through the signaling equipment of Fig. 20, with the result shown in oscillogram No. 5. The oscillogram No. 127 of Fig. 21 shows the voltage on the battery side of the coils as trace No. S and the simultaneous result on the line side as trace No. 1. The line current is trace No. 2. This shows that the line voltage and current are practically in phase. Consider-

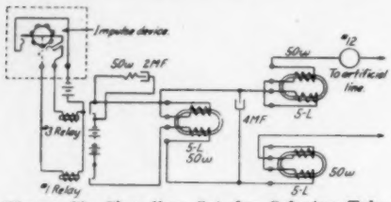


Figure 20—Signaling Set for Selector Telephone Circuits with 3-5L Coils.

able delay in the progress of the wave on the line is indicated both at the make and break of the circuit. The condensers in the middle of the retard coils act as a storage battery and assist to prevent the sudden collapse of line voltage when the relay opens. They also cause high initial e.m.f. in the coil between them and the battery when the

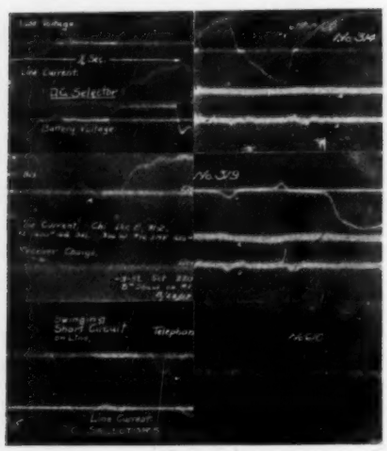


Figure 21.

relay closes, thus rounding off and delaying the growth of the line wave. The resultant current wave on an actual line is shown in No. 101. This was taken on a 110-mile dispatching No. 9 A.W.G. copper wire circuit, Indianapolis to Cincinnati, equipped with 32 Sandwich type 4-G selectors, with a main battery of 220 volts. In No. 101 the capacity of the telephone condensers added to that of the line causes a decided oscillatory action at the end of the impulses. This is aided by the capacity and retardation in the wave modifying set.

The cause of the vicious sound in the receiver which occurs due to a swinging short circuit on the line while selector impulses are being sent, is shown in oscillogram No. 15. The upper trace is the telephone condenser wave and the lower is the line current. The short circuit is removed at about the middle of the wave, with sudden

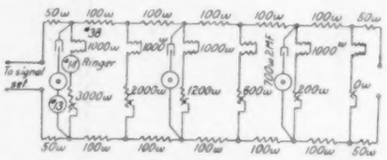


Figure 22—Artificial Selector Telephone Circuit.

increase in line voltage, with resultant rapid changing of the condenser in the telephone receiver circuit which causes the disagreeable sound shock.

The condenser signal sending set of Fig. 23 was recorded in No. 50 and No. 51 of Fig. 24, sending impulses into this artificial selector line, first with 125 volts main charging battery and then with 325 volts. This type of sending circuit is in use to a limited extent on some railroads. The brevity of the line current wave is the outstanding feature of these two records.

The above mentioned dispatcher's selectors on the Indianapolis-Cincinnati dispatcher's telephone line were replaced by 32 Western Electric Co. alternating current selectors, type 60-A, with wiring as shown in Fig. 11.; and oscillogram No. 380 shows the current in the battery side of the repeating coils as trace No. 1 and in the line as trace No. 2. This circuit has the condensers removed from the selectors and lumped in the battery side of the repeating coil. The impulses as registered in the line at the sending station on the Indianapolis-Kankakee dispatching telephone circuit, a 140-mile No. 9 A.W.G. copper circuit of 35 No. 60 alternating current selectors, is shown in No. 590, in which trace is the line current. These selectors are operated with a condenser in series with each selector and with the main battery applied directly to the line. It will be noted that the first impulse, which is the closure of the No. 122-E W relay, is but half the amplitude of the following impulses. Oscillogram No. 591 is the Kankakee circuit line current with the repeating coil signaling set of the Cincinnati circuit sending impulses. The resulting impulses are only half the amplitude of the impulses of the regular signaling set, shown in No. 590. This method is now being experimented with. It is the more desirable plan, because with condensers in the bridging selectors the wire chief can make accurate Varley loop Wheatstone bridge measurements for trouble. If the direct battery ringing set of the Kankakee line is put on the Cincinnati circuit which has the condensers removed from the selectors, the result is as shown in No. 388-C, trace No. 1, which is the line current.

Oscillograms No. 319 and No. 314 of Fig. 21 show the comparative impedance of a No. 47-A repeating coil and a D-12984 coil, which is used for the signal sending repeating coil for alternating current selectors and also as a simplex coil for the "distant" end of such circuits. Trace No. 1 of No. 314

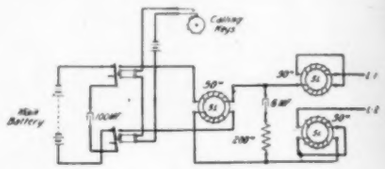


Figure 23—Condenser Type Signaling Set for Selector Telephone Circuits.

is the current in the No. 47-A coil at the Indianapolis end of an Indianapolis-Bellefontaine No. 9 A.W.G. copper alternating current selector line 140 miles long, equipped with 45 a-c. selectors not operated through a repeating coil at the sending end, but with the battery applied direct to the line at Bellefontaine.

Trace No. 2 is the current through

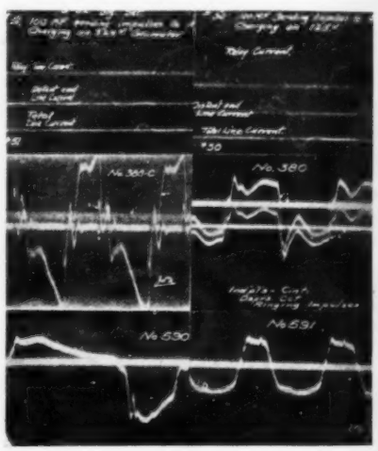


Figure 24.

the selector which had two microfarads capacity in series with it. Trace No. 3 is in the phantom telephone branch on this circuit. In No. 319, trace No. 1 is the current through a D-12984 coil. The lobes of this wave on the short impulses are much smaller than on No. 314, indicating much less effect on the line current, while the continuous impulse is somewhat the same shape in both.

No. 610 shows the current through the D-12984 coil at Indianapolis after the condensers from the selectors had been lumped in a repeating coil type of signal sending set of Fig. 11, at Bellefontaine.